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Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

No. 175

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BRIEFS

INDIAN URANIUM TRANSFER PROHIBITED--Australia says its uranium will not find its way to India despite the recent signing of a uranium supply deal between India and France. The minister for national development and energy, Senator Carrick, said there was continuous monitoring of the use of Australian uranium sold to France. Senator Carrick told the senate there could be no transfer of Australian-supplied enriched uranium to India without Australia's consent. He said Australian consent would not be forthcoming because India had not signed a bilateral agreement with Canberra nor had it signed the international safeguards agreement. [Text] [BK021011 Melbourne Overseas Service in English 0500 GMT 2 Dec 82]

U.S. HOUSE DECISION VIEWED--Australia has applauded a decision by the U.S. House of Representatives to reject new limits on American imports of uranium. The acting prime minister, Mr Anthony, says the decision is a major defeat for forces in Congress seeking to protect less competitive American uranium miners. The import restriction measures will now go back to the American Senate. However, Mr Anthony says the strong vote makes it unlikely they will be adopted by Congress for the time being at least. He says the decision Strongly backed by the Reagan administration will benefit American consumers and remove a threat of disruption in the world uranium market. Mr Anthony says any other decision would have amounted to a reversal of the Reagan administration policy to end all restrictions on uranium imports by next year. [Text] [BK031722 Melbourne Overseas Service in English 0830 GMT 3 Dec 82]

CSO: 5100/4318

OFFICIAL BRIEFS PARLIAMENT ON NUCLEAR ENERGY

BK251407 Jakarta Domestic Service in Indonesian 0700 GMT 25 Nov 82

[Text] The director general of power plant of the mining and energy department, Semaun Samadikun, has said that there is still no urgency for the use of nuclear energy in Indonesia as the country still has plenty of other energy sources, such as water, coal, oil and gas. He made these remarks during question time today with Commission-6 of the Parliament, which was presided over by the commission's deputy chairman, Abdul Azis Larekeng.

Surveys in the country have shown indications of uranium deposits at several sites, including Kalimantan. If the potentials of these uranium deposits are found to be big, they will be utilized to generate nuclear power in the future.

Semaun Samadikun said we need to take into consideration technical and economic factors if we are to utilize nuclear energy because of the high costs and advanced technology involved. In addition, problems of environment, security and safety and the storage and disposal of nuclear waste must also be taken into account. In this connection, Indonesia plans to construct a 30 mw multipurpose reactor in Serpong, West Java, to solve these problems. The plant is expected to be operational by 1986.

CSO: 5100/4317

JAPAN'S ATOMIC ENERGY WHITE PAPER FOR 1982 PUBLISHED

Tokyo JAPAN PETROLEUM & ENERGY WEEKLY in English 1 Nov 82 pp 1, 2, 3, 4, 9

[Text] On October 26 the Atomic Energy Commission (headed by Science and Technology Agency Director-General Ichiro Nakagawa) issued a white paper on atomic energy for 1982 -- the 25th such paper published in Japan. (October 26 is a day observed as the Atomic Energy Day in Japan.)

The white paper's highlights are, among others:

- Present status of Japan's nuclear power development

Japan's peaceful utilization of atomic energy has centered on the development of nuclear power generation, with a total of 24 nuclear power reactors having a combined capacity of 17,177 megawatts now in operation. (In addition, a 165-megawatt prototype advanced thermal converter reactor "Fugen" has been in operation since March 1979.) Japan ranks third in the world in terms of nuclear power reactor capacity, after the U.S. (77 reactors; 60.82 million kw as of December 31, 1981) and France (30 reactors; 23.02 million kw)*.

In addition to the aforementioned 24 reactors, 19 reactors with a combined capacity of 18,067 megawatts are either under construction or in planning. Altogether, these plants will increase Japan's total nuclear power generating capacity to 35,244 megawatts by the end of 1991 -- the total of projects approved so far by the Electric Power Development Coordination Council (chaired by the Prime Minister).

- Nuclear power's position in Japan's energy system

Nuclear power generation exceeded the hydropower generation for the first time in fiscal 1981 (which ended March 31, 1982). Nuclear power generation in fiscal 1981 totaled 87,231 million kwh, which represented 16.7 percent of Japan's total electric power generation of 523,144 million kwh (excluding the power generation by non-electric enterprises), with hydraulic and thermal power generation representing 16.0 and 67.3 percent, respectively.

(*) According to a report published on March 29 of this year by the Japan Atomic Industrial Forum, Inc., the world's total capacity of nuclear power reactors in operation as of the end of 1981 reached 165,927 megawatts with 266 reactors. Japan is followed by the Soviet Union (30 reactors; 15.6 million kw), West Germany (12 reactors; 10.3 million kw), and the UK (32 reactors; 8.8 million kw) (JPEW, Apr. 5--pp 11/12).

Nuclear power, along with coal, LNG, and hydropower, now constitute the four major pillars of non-oil, alternative energy sources for Japan, accounting for 5.1, 17.0, 5.8, and 5.7 percent, respectively, of the nation's total primary energy supply of 7.24 million barrels per day of oil equivalent in fiscal 1980 (JPEW, Dec. 28, 1981 - p 5).

Japan's latest revised supply targets for alternative energy sources in fiscal 1990 envisage 5.2 million barrels per day of oil equivalent: 1.98 million b/d from coal; 1.17 million b/d from natural gas/LNG; **1.16 million b/d from nuclear power (46-million-kw reactors generating 255 billion kwh annually, accounting for 30.1 percent of total power generation in 1990);** 0.52 million b/d from hydropower; and the balance from geothermal and other energies.

All these alternative energy sources are expected to total 50.9 percent of Japan's overall primary energy supply in fiscal 1990 (JPEW, Apr. 26 -- p 9). **By the year 2000,** it is **projected that nuclear power reactor capacity will be increased to approximately 90 million kw, generating 520 billion kwh annually, or about 43 percent of total power generation in that year.**

- **Siting of nuclear power plants**

Quite to the contrary of the spectacular growth in nuclear reactor capacity, Japan's nuclear power industry faces a serious problem due to local residents' hostile reaction to nuclear facilities, and such opposition causing considerable delays in the construction of new nuclear power reactors at a number of sites throughout the country.

Taking into account the fact that long lead times are required before the nuclear power reactors go onstream, **sites must be chosen within the next two years to construct additional reactors with a total capacity of 11 million kw** (i.e., the difference between the 46 million kw targeted for operation by 1990 and 35 million kw now in operation and under construction or in planning at sites which have already been decided). The government as well as the electric utility industry are being urged to make utmost efforts to achieve the above objective.

- **Unit capacity factor**

The average unit capacity factor of Japanese nuclear power reactors has improved remarkably in recent years, with **the April-September 1982 period witnessing the average of 73.6 percent** (vis-a-vis 65.9 percent registered during the corresponding period of last year). (JPEW, Oct. 18 - p 3).

- **Economic advantage of nuclear power**

Nuclear power's economic advantages over hydropower and thermal power has become increasingly conclusive today, as oil and coal prices have sharply increased. Of the three non-oil alternative fuels for generating electricity (coal, LNG and nulcear), coal and LNG are both fossil fuel sources easily influenced by oil price fluctuations and these fuel prices

represent comparatively higher percentages of the total power generation costs than uranium fuel prices do.

This means that a shift from thermal power generation which is primarily dependent on imported fossil fuels to nuclear power generation will bring about large savings in foreign exchange on the one hand, while on the other hand the promotion of capital-intensive nuclear power development projects will help stimulate domestic business activities.

An estimate based on a power plant going onstream in the current fiscal year points to the decided advantage the nuclear power has over thermal power, as shown below:

	Power Generation Cost (at transmission end) ¥/kwh	Power Generation Cost (at transmission end) US¢/kwh
Nuclear power	12	4.4
Thermal power: Oil & LNG	19-20	7.0-7.4
Coal	15	5.6

This economic superiority of nuclear power as referred to above will not be affected even when additional costs inherent to nuclear power generation such as reactor decommissioning and radioactive waste disposal costs are also included.

- **Utilization of plutonium**

The utilization of plutonium and uranium recovered from reprocessing of the spent fuel must be promoted in the following manner:

i) In order to establish independent control over plutonium utilization, spent fuel will be reprocessed, and in principle it will be reprocessed domestically.

ii) **It is Japan's basic policy to utilize plutonium recovered from spent fuel in fast breeder reactors,** which are expected to commence commercial operation at around the year 2010.

iii) However, **until the time comes when the fast breeder reactors become operational, the plutonium will be used as fuel for thermal reactors.** For this purpose efforts will be made to incorporate advanced thermal converter reactors into the electric power generation system, as well as to use the plutonium in light-water reactors. The plans for both of these projects call for the completion of demonstration tests by the mid-1990's, followed by their commercial operation.

iv) The uranium recovered from the spent fuel will be re-enriched for use as fuel in light-water reactors, or mixed with plutonium for use as mixed oxide fuels (MOX).

- **Demonstration advanced thermal converter reactor**

The Atomic Energy Commission decided in August of this year that the semi-governmental Electric Power Development Company (EPDC) will be in charge of construction and operation of a demonstration advanced thermal converter reactor (600 megawatts). The demonstration plant is expected to go onstream in 1994.

- Uranium supply and demand

Since Japan's indigenous uranium reserve is limited to about 10,000 short tons, Japanese electric utilities have signed long-term natural uranium purchase contracts with Canada, U.K. and Australia, now assuring a supply of total 177,000 short tons (U_3O_8 basis). In addition, the Tokyo-based Overseas Uranium Resources Development Co., now producing natural uranium in Akouta, Niger, in a joint venture with a French company, supplied 3,000 short tons of uranium to Japan in fiscal 1981, and is expected to supply a total of 20,000 short tons to Japan. Altogether, these supplies will meet Japan's requirements through the early 1990's, while the demand through the year 2000 is projected to total approximately 310,000 short tons, thus making it necessary to assure the supply of additional 110,000 short tons by 2000.

- Uranium enrichment

Japan now relies on the U.S. and France for uranium enrichment, receiving 6,000 tons SWU (separative work unit) and 1,000 tSWU per year of enrichment services, respectively, under long-term contracts. These service contracts will meet Japan's requirements through around 1990.

The semi-governmental Power Reactor and Nuclear Fuel Development Corp. (PRNFDC) built a pilot plant for uranium enrichment, which went into operation in September 1979 at the Ningyo Pass, Okayama Pref. and reached its maximum capacity in March 1982, producing more than 50 tSWU per year of enriched uranium. Present plans call for construction and operation of a prototype plant of 200 tons SWU/year and of commercial plants of 1,000 tons SWU/year by around 1995 and 3,000 tons SWU/year by around 2000.

- Reprocessing of nuclear fuel

Japanese electric utilities have signed contracts with BNFL of England and COGEMA of France for reprocessing of spent nuclear fuel to obtain a total supply of approximately 5,700 tons of uranium.

Meanwhile, Japan and the U.S. agreed on October 30, 1981, that the U.S. would permit Japan's reprocessing plant (which was built by PRNFDC at Tokai-mura, Ibaraki Pref. and started reprocessing in September 1977) to reprocess up to 210 tons per year, until a long-term agreement is concluded by the end of 1984.

Plans are now under way for the private company, Nuclear Fuel Service Co. (established on March 1, 1980 by a consortium of electric utilities), to construct a 1,200-ton-a-year reprocessing plant for operation by around 1990.

- Fast breeder reactors

The "Joyo," an experimental fast breeder reactor (built by PRNFDC at Oarai, Ibaraki Pref.), attained the initial criticality for nuclear fission in April 1977, and has continued to operate smoothly, providing valuable technical data and the operational experiences necessary for development of a prototype reactor. The reactor core of the Joyo (with its maximum thermal output of 100 megawatts) is to be modified in fiscal 1982 to perform irradiation tests of fuel and materials.

Plans for constructing "Monju," a prototype fast breeder reactor (with thermal output capacity of 714 megawatts and electric output capacity of 280 megawatts), have made a great stride forward this year, as the Fukui Prefectural Gnvernment in May consented to construction of the Monju at Tsuruga, Fukui Pref., and a public hearing was conducted in July to obtain public acceptance of the local residents.

CSO: 5100/4209

SAFETY FEATURES OF FBR MONJU DISCUSSED

Tokyo ENERUGI FORAMU in Japanese Sep 82 pp 109-113

[Article: "Safety of 'Monju' Supported by Independent Technology; Response and Confidence Confirmed by Our Own Hand"]

[Text] Deep-Rooted Apprehension Regarding Safety

"Almost all fear and animosity regarding an enterprise are rooted in distrust of things of unknown character. In fact, the contribution to the society made by the enterprise activity and its limitations are hardly understood by the public today. When human beings are afraid of something, especially if that fear is based on ignorance, they try to control that thing. It is the same whether the thing is a huge animal or a huge enterprise. They don't like to see the enterprise running around loose without a collar and leash."

Although it is a little lengthy, the quotation is a paragraph taken from "The Law of Public Information," a book by C N Parkinson, who is famous for Parkinson's law. This writing described the public's perception (including the psychological aspect) of giant enterprises in this industrial society. If the word "enterprise" is replaced by the word "giant technology" or "nuclear power" in this writing, then it provides a revealing profile of the public's apprehension and distrust regarding atomic power, representing today's big technology and big science, in general, and of those who live in an area where atomic power is to be introduced in particular.

This is particularly true regarding "Monju", the first FBR representing the next-generation atomic power generating system to be built in Japan. The increased anxiety and distrust of it on the part of the local society is probably unavoidable, so the matter should be modestly accepted. The FBR prototype "Monju" which is to be built at Shiraki-ku, Tsuruga City faces exactly this type of situation.

Therefore, the fact that "Monju" is not something of unknown character but rather something that can contribute significantly to the national economy as well as to the local society must be repeated again and again in order to gain the local society's understanding. Moreover, it is not "something running around without a collar and leash", but rather a system whose safety has been confirmed and controlled by "Donen" (Power Reactor and Nuclear Fuel Development Corporation), which is at the center of its development.

Furthermore, its safety is guaranteed by a double-check system consisting of a primary safety inspection by the Science and Technology Agency (STA) and a secondary safety inspection by the Atmoic Power Safety Commission (APSC). During the process of each inspection, a public hearing is held in which the local society's apprehensions and questions are answered. The local meeting in which the primary inspection results are expalined is followed by a public hearing in which the voice of the local society can be heard by the safety inspection commission.

In this sense, the FBR "Monju" will be designed and built and operated "with many collars and chains" under the supervision and cooperation of the local society.

About 2 months have passed since a public hearing was held at the Citizen's Culture Center on 2 July at the planned construction site of Tsuruga City. Shiraki-ku of Tsuruga City, which is located at the northern end of the Tsuruga Peninsula in Fukui Prefecture, was chosen in 1970 by "Donen" (executive director: Masao Segawa) as the construction site of "Monju". Considerable amount of time was spent in obtaining local consent, and preparatory investigation of the site started in July 1976. Environmental investigation began in earnest in November 1978, and the investigative report was examined by the state as well as the prefecture. The results of the enviornmental examination were explained to the local public in September 1980, and an application for construction of the nuclear reactor was accepted in December of the same year. Thereupon, the primary safety inspection was carried out by the STA. A local meeting in which the findings of the primary safety inspection were explained to the local public was held in February 1982, and upon local approval the secondary safety inspection is being carried out by the ASPC today.

As part of the secondary safety inspection process, a public hearing is held in which the STA responds to the inquiry made by the ASPC concerning various aspects of safety, and the opinions of the local public are heard by the ASPC so that these views may guide the commission in its conduct of the safety inspection.

A lively hearing was held out in the presence of an audience numbering approximately 650. Statements of opinion were made by 20 representatives, including Shozo Hashimoto, chief of the Shiraki-ku where "Monju" is to be built, and others representing the concerned neighboring towns such as Makino-cho and Yokure-cho of Shiga Prefecture. This time, too, the group opposing the construction of nuclear power generating station, centered around the "Fukui Prefecture Citizen's Committee Against Nuclear Power Generation" (represented by committee member Koji Tokioka), boycotted the public hearing. The hearing was conducted amidst opposition and obstruction activities carried out spiritedly outside the meeting hall.

Inside the meeting hall, the statements of opinion were made in groups according to content, including: 1) natural conditions such as the strength of the ground at the construction site, 2) plutonium countermeasures, 3) sodium countermeasures, 4) safety evaluation, 5) operation controllability, and 6) other topics such as concentrated location, waste reactor, and disaster

prevention countermeasures. Almost all of the speakers frankly and directly expressed their apprehensions and questions concerning safety. The majority expressed their "conditional approval" with strict conditions. The acting chairman, Eizo Tajima, representing the ASPC which sponsored the hearing, evaluated the results of the hearing at a press conference held afterward: "Although it is regrettable that the crowd outside the meeting hall was very noisy, inside the hall enthusiastic and substantial opinions and questions were voiced. These will be reflected in the safety inspection."

Taking into consideration the opinions and questions expressed during the public hearing, the ASPC will carefully carry out the secondary safety inspection. It will report its findings and conclusion to the prime minister sometime next summer. Thereupon, "Donen" may start construction work in earnest. The criticality target date is expected to be in 1990, 3 years later than the original target date of 1987.

Donen is currently speeding up the process of getting the construction permit from the prefectural government so that this fall it can start the preparatory work, including construction of a road along the coast from Shiraki village to the reactor construction site.

How Different Is It From a Light Water Reactor?

"Monju" is a sodium-cooled FBR. It is the prototype which follows the experimental reactor "Joyo". While the experimental reactor "Joyo" did not generate any electricity, "Monju," which is a prototype power generating plant just one step short of a proven reactor, is capable of generating 280,000 kW of electric power.

"Monju" consists mainly of the following parts: 1) the "reactor core", where heat is generated by nuclear fission consisting of a reactor core fuel assembly, a blanket fuel assembly, and control rods; 2) "sodium cooling system equipment" which transfers heat; 3) a "steam generator" where water is turned into steam by means of heating; and 4) a turbine generator which generates electricity.

The heat generated in the reactor core as a result of nuclear fission is carried away by sodium in the primary cooling system. This heat is then transferred to sodium in the intermediate heat exchanger. The heat is finally transferred to water from sodium inside the steam generator. The steam thus generated is used to drive the turbine generator which generates electricity.

If the circulating pump and the intermediate heat exchanger are situated outside the nuclear reactor housing and are connected to the equipment inside via piping, such construction is commonly known as a "loop type." If the circulating pump and the intermediate heat exchanger are situated inside a large reactor housing, such construction is commonly known as a "tank type". France's "Phoenix" and "Super Phoenix" belong to this type. One of the special features of the "loop type" is that the primary cooling system and the secondary cooling system are connected via the intermediate heat exchanger which is located at a distance from the nuclear reactor housing. "Coolant sodium" is used as the medium to transfer the heat generated inside the reactor core from the primary cooling system to the secondary cooling system.

The FBR is similar to the light water reactor, which constitutes the mainstream of today's atomic power generating systems as far as the scheme used in generating electricity is concerned. Namely, the heat generated inside the nuclear reactor is utilized to generate steam, which is then used to drive the turbine generator which generates electricity. However, the FBR is basically different from the light water reactor in the following three aspects.

First of all, "fast neutrons" are used instead of thermal neutrons. Second, "sodium" is used as coolant instead of water. Third, "plutonium" is used as fuel instead of uranium.

Why is this? First, if fast neutrons are used instead of thermal neutrons, then the number of neutrons produced by nuclear fission will be larger and new fuel will be created in large quantity. Second, sodium used as coolant does not retard the neutrons very much and is a better conductor of heat. Moreover, a low-system pressure can be used even for a higher temperature operation because its boiling point is high. Third, the number of neutrons generated from the nuclear fission of plutonium is greater than that obtainable from uranium. At the same time, uranium-238, which does not burn easily in a light water reactor, can be converted into plutonium and burned in an FBR. The FBR has these special features and numerous other advantages.

The FBR is capable of "breeding" precisely because of these three differences. Fast neutrons and plutonium-239 are used in the FBR, so the number of neutrons created by nuclear fission is 3 (2.5 for light water reactor). One of the three neutrons strikes plutonium and thus maintains nuclear fission. When the other two neutrons are effectively absorbed by uranium-238, the uranium-238 is converted into plutonium and thus new fuel is created (breeding). The breeding rate of "Monju" is 1.2 according to design (at a combustion degree of 80,000 kW day). Breeding is possible due in part to the use of sodium as coolant, because sodium does not retard neutrons very much.

However, the basic objective of the nuclear reactor safety design is, needless to say, to "expose the general public living in the vicinity of the power plant and the employee of the plant to no more than the allowed amount of radiation during a normal operating period," or going one step further, to "expose the general public living in the vicinity of the power plant to as little radiation as reasonably possible due to the radioactive waste material that may be discharged from the plant, in accordance with the spirit of the recommendation made by the International Commission on Radiological Protection" (ALARA).

The basic objective of nuclear reactor safety design remains the same in this FBR as in the conventional light water reactor. However, a safety design and safety system unique to "Monju" are required to achieve this objective because of the three basic differences between Monju and other light water reactors. That is why the local residents are concerned about its safety as clearly expressed in the public hearing mentioned above.

Safety Design and Countermeasures of "Monju"

Now then, what kind of safety design and countermeasures were made concerning the FBR "Monju"? The objective of the safety countermeasures of the nuclear reactor facility, as mentioned above, is "to prevent the dangerous radioactive

substances contained inside from getting out." In other words, "to contain the radioactive substances inside." That is why a nuclear reactor is constructed with many layers of protective wall.

The first protective wall consists of the way in which the fuel pellets are made. Namely, the mixed oxide fuel pellets containing approximately 20 percent plutonium and uranium are sintered into hard solid pellets. The second protective wall consists of a stainless steel tube which seals in the fuel pellets and thus completely separates the fuel pellets from the primary sodium coolant which circulates outside the stainless steel tube. The third protective wall consists, in addition to the primary coolant boundary (nuclear reactor housing, piping, etc), of many layers of barriers including the nitrogen-filled chamber for the primary cooling system, the nuclear reactor hanger container, and the external shielding building. Furthermore, "Monju" belongs to the so-called "loop-type" construction, in which the primary and the secondary sodium cooling systems are connected via an intermediate heat exchanger located outside the nuclear reactor housing, so the radioactivity can be contained inside the primary system inside the hanger container.

In addition to these structural protective measures, the design of "Monju" also employs the following safety measures. First, in order to prevent as much as possible the failure and breakage of machinery which constitute the causes of accident, the machineries are designed with the ample safety margins and manufactured under the strictest quality control. An extensive inspection system with a large number of checkpoints is employed, and in order to prevent an abnormal situation due to mistakes in action and operation from taking place; an elaborate fail-safe system and an interlocking system are employed. The structure is also capable of withstanding natural disasters such as earthquakes and artifical disasters such as fire. A "fail-safe" system is one in which the safety of the system can be maintained automatically, even if a portion of the system may fail. An "interlocking system" is a system which is capable of preventing an accident automatically even if a mistake in operation is made.

Second, if an abnormality should take place, the automatic surveillance system can quickly detect it and take appropriate action before it can develop into an accident. The nuclear reactor emergency shut-off system can be activated in case of an abnormality.

Third, even those accidents which are highly unlikely to occur from the technical standpoint are taken into account, and countermeasures are designed so that the radioactive substances can be prevented from being discharged.

In addition to these multiple layers of structural and system safety measures, there is another safety factor which is inherent to the nuclear reactor. It is the so-called "Doppler effect." If the fuel temperature inside the reactor core increases, the amount of resonant absorption also increases, so as the fuel temperature inside the reactor core increases, the reaction rate of the reactor decreases and the reactor output is suppressed. As a result, the reactor tends to restore its steady state output and safe operation by itself. Therefore, if an accident should cause an abnormal increase in the reactor output, the Doppler effect would effectively suppress a further rise in the reactor output and thus prevent meltdown of the reactor core.

Of course, we must not rely on this safety factor which is inherent in the nuclear reactor. We must prevent the meltdown of the reactor core from ever taking place. If an abnormality of the nuclear reactor should take place, the reactor must be shut down immediately and the heat of decay removed as soon as possible by a number of duplicate methods. Therefore, needless to say, this reactor is also equipped with an emergency shutdown system and a heat of decay removal system.

For example, the main reactor shutdown system of "Monju" consists of 3 fine regulating rods and 10 course regulating rods, while the reserve reactor shutdown system consists of 6 shutdown rods. The scram format includes the simultaneous dropping of both the control rod and the drive shaft as well as the dropping of the control road only. The acceleration format includes both pneumatic pressure and spring force. The position before scram includes both partially inserted into the reactor core and completely withdrawn. A combination of two systems is used in each case to insure the duplication and diversity.

The same can be said of sodium used as the coolant. Sodium has a large thermal conductivity and a boiling point of 880°C which is 300°C higher than the temperature of sodium inside an operating nuclear reactor. Therefore, the plant can be designed to operate at reduced pressure. This provides the following safety features inherent to sodium used as coolant.

First, if a leak should develop, the coolant will not gush out as in a light water reactor, because the internal pressure is lower.

Second, if a leak should develop in the primary sodium cooling system, the sodium can be securely contained inside the nuclear reactor housing, and the possibility of losing the coolant can be made negligible by simply arranging piping at higher places so as not to expose the reactor core, and installing a guard vessel (a container surrounding the nuclear reactor housing, pump, and the intermediate heat exchanger). Therefore, to cool the reactor core in an emergency or to remove the heat of decay in an ordinary period, what is needed is to cool this sodium which is kept inside by some means. On occasion, this can be accomplished by the natural circulation of sodium alone. An experiment was carried out to prove this natural circulation power using "Joyo" under a simulated worst condition of total electric power loss. It was confirmed from this test that the heat of decay could be removed by the natural circulation of sodium alone.

Moreover, there are three main cooling systems in "Monju". Even if one system should fail completely, the other two sound systems are capable of cooling the reactor core after the reactor is shut down. Here again, duplicate systems and methods are used to insure a single function.

That is why "Monju" does not need any emergency core cooling system (ECCS) as in a light water reactor.

On the other hand, sodium is chemically very active. It reacts readily with water and will burn in the air. Thus, its dangerous nature is often considered an issue. However, this problem can be solved by taking the following design

and structural measures so that this property cannot be manifested: 1) the liquid soldium surface is completely covered with an inert gas, argon; 2) the atmosphere of the chamber containing the radioactive sodium is completely replaced with nitrogen; and 3) the interior of the room is covered completely with steel plate in order to contain any sodium that may be leaked.

Furthermore, a barrier is installed to separate the radioactive sodium from coming into direct contact with water in case of an accident. The design concept involving transfer of heat from the radioactive sodium (primary cooling system) via an intermediate heat exchanger and using that heat to generate steam is a concrete example of this measure. "Monju" is thus designed to take full advantage of the good features of sodium cooling, while its shortcomings are prevented from displaying themselves by appropriate design countermeasures.

Strength and Confidence of Independent Technology

The strength of "Monju", as was mentioned in the beginning, consists of the fact that its safety is supported by responses confirmed by our own hand. Unlike the light water reactor, whose development depended on imported technology, development of Japan's FBR is being carried out as a national project step by step, from the experimental reactor through the prototype reactor and the proving reactor to the practical reactor. The development effort is being undertaken independently from the early stage of basic research. It will soon be a full 15 years since "Donen," which is mainly responsible for its development, was established in October 1967. During this period, numerous developmental tests, including the development and testing of the sodium handling equipment and the steam generator at the Oarai Engineering Center, were followed by the design, construction, operation, and maintenance of an experimental reactor "Joyo" to verify the safety and to carry out other research and development activities such as irradiation testing.

Above all, the experimental reactor "Joyo" (final thermal output 100,000 kW), which may be called a compact version of "Monju", has logged about 13,000 hours of operating time since it reached criticality in April 1977 up to today. "Joyo," which is a product of this independent technology, achieved the first period rated output of 50,000 kW in July 1978, and succeeded in operating at the second period rated output of 75,000 kW 1 year later, in July 1979. Operation at this output level continued to the end of 1981. This is known as the Mark I reactor core. Today, construction of the Mark II reactor core is under way. Operation with a rated output of 100,000 kW is expected to begin in the spring of 1983.

The objectives of "Joyo" may be roughly divided into two parts. The first objective consists of accumulating experience and technical knowhow in the design, construction, testing, operation, and maintenance of the FBR. These activities will be carried out throughout the period of the Mark I and Mark II reactor cores. The second objective is to utilize the Mark II reactor core as a fast neutron irradiation reactor in earnest and carry out research and development of fuel and material used in the FBR. This work can be carried out only after the Mark II reactor core is ready.

On the other hand, research and development of one of the most important pieces of machinery in an FBR power plant--the steam generator--including construction and operation, or the so-called mockup test of a 1 MW steam generator experimental facility, a 50,000 kW steam generator experimental facility, and a 50,000 kW steam generator actual facility, were also carried out. As a result of this effort, a helical coil type steam generator, which may be termed the fruit of domestic technology, has been developed which will be used in "Monju." The helical coil type steam generator consists of a bundle of helical coil pipes through which water flows placed inside a sodium flow. This type of high-efficiency steam generator can be made compact in size. However, advanced technology is required for its construction. This technology of Japan has the highest standard in the world today.

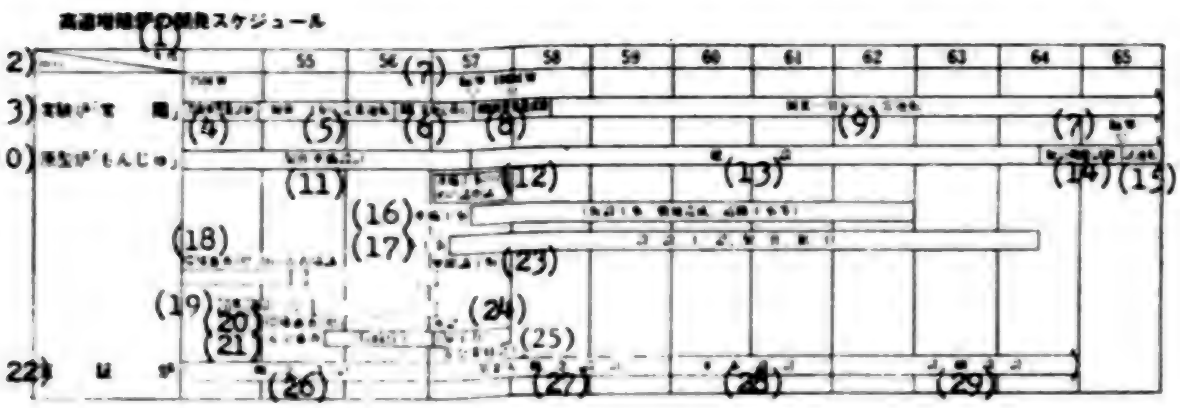
One 50,000 kW steam generator, which is a one-fifth scale model of "Monju," of the helical coil type consists of a boiler and a superheater, it is capable of generating steam at 132 kg/cm^2 and 487°C, the same quality of steam used in "Monju." The proving test of this large-scale steam generator is being carried out in two stages. First, the structural problems associated with large-scaling become apparent with the first unit. At the same time, its heat transfer and flow characteristics are evaluated. Second, a second unit having heat transfer tubes of different diameter, number and length and using different supporting method, assembling method, and material is constructed and tested in order to gather the pertinent data needed to achieve optimum design of the steam generator used in "Monju". The first unit has completed its work and has been disassembled to be subjected to the material test. By December 1981, the second unit had logged 12,000 hours of continuous operation.

The important safety problem posed by the steam generator consits of "sodium-water" reaction. In the steam generator, water or steam flows inside a heat transfer tube have a wall approximately 3 mm thick, while sodium flows outside the tube. If sodium comes into contact with either water or steam, a violent chemical reaction takes place, and heat or pressure will be generated. In order to maintain the safety of the steam generator, we must completely understand the nature of this reaction and include countermeasures for it in the design itself. At the same time, we must also establish a method of detecting it. Extensive testing and research were carried out over a period of about 10 years for the purpose of establishing the safety of the steam generator. Specifically, a big leak Na-water reaction test facility (SWAT 1), a small leak Na-water reaction test facility (SWAT 2), and a steam generator general safety test facility (SWAT 3) were used.

SWAT 1 and SWAT 2 are test facilities ued to gain an understanding of the phenomenon that would take place inside a steam generator directly affected by an accident involving sodium-water reaction. On the other hand, SWAT 3, is a 2.5 times reduced-scale model of the secondary cooling system of "Monju". It is used to prove the safety of Monju's steam generating system regarding an accident involving water leak by a test carried out in a system which is nearly full scale. Numerous proving tests were carried out by simulating the water gushing rate equivalent to the failure of a heat transfer tube. Today, the steam generator water-leak countermeasures are an established independent technology.

Dr Enrico Fermi, who successfully carried out the first sustained chain reaction of nuclear fission in all human history, predicted in 1945: "The country which develops the breeder reactor first will be in a very advantageous position in the race for atomic power generation." Development of the FBR in Japan is about to make a giant leap with its prototype reactor "Monju." It is supported by the safety assurance established by an independent technology developed by our own hands.

FBR Development Schedule



Key:

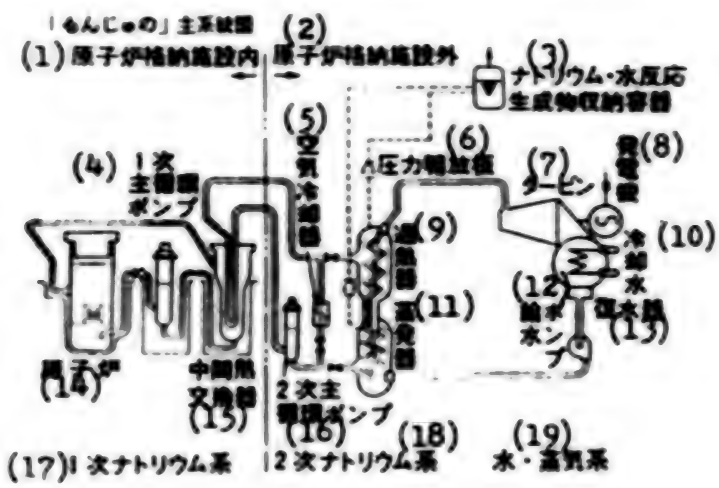
1. Year, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990
2. Items
3. Experimental reactor "Joyo"
4. 75 MW performance test
5. MK-I reactor core steady operation
6. Transition to MK-II reactor core
7. Criticality
8. 100 MW performance test
9. MK-II reactor core steady operation
10. Prototype reactor "Monju"
11. Preparation and design
12. Various applications for the preparatory work
13. Construction
14. General performance test
15. Trial run
16. Preparatory work (temporary work, ground preparation, road construction, etc)
17. Main construction work (design, approval, construction, installation)
18. Environmental investigation (prefecture, state) various departments consulted
19. According to nature and park law
20. Environmental investigation (prefecture)
21. Safety inspection (STA, ASPC)

(key continued on next page)

Key continued:

22. Proven reactor
23. Cabinet approval
24. Approval
25. Safety Committee
26. Conceptual design
27. Secondary conceptual design
28. Basic design
29. Detailed design

Main System Diagram of "Monju"



Key:

1. Inside the nuclear reactor hanger
2. Outside the nuclear reactor hanger
3. Sodium-water reaction products container
4. Primary circulating pump
5. Air cooler
6. Pressure relief valve
7. Turbine
8. Generator
9. Super heater
10. Cooling water
11. Boiler
12. Feed water pump
13. Condenser
14. Nuclear reactor
15. Intermediate heat exchanger
16. Secondary circulating pump
17. Primary sodium system
18. Secondary sodium system
19. Water/steam system

9113
CSO: 5100/4201

CSSR'S ORIENTATION TO NUCLEAR POWER SEEN NECESSARY

Prague TRIBUNA in Czech No 46, 1982 p 13

/Article by Milan Reitr: "Orientation to Nuclear Power"/

> /Text/ The rapid technical and economic development of advanced industrial countries after World War II was making exceptionally heavy demands on the fuel and power production base and on the world reserves of fuels. Of course, the sources of classic feuls are not inexhaustible. Furthermore, they are distributed unevenly in the world and in various degrees of quality. Some fossil types of fuels can be considered to be the basic fuel production base in the CSSR as well as in some other countries only until the end of this century, and perhaps for a few additional dozens of years after the year 2000. This applies especially to lignite and hard coal. Other refined fuels, particularly crude oil and natural gas, have become raw materials which are too costly and have to be used very carefully and economically.

In view of the limited reserves, the development of the classic fuels in the world and in the CSSR led to searches for other sources of energy. As in other industrially advanced countries, nuclear energy is also developing in the CSSR. It is based on all-round cooperation with the USSR, without which such development would be unthinkable. The development and application of nuclear power in the CSSR is an inevitable necessity, and for the next few decades it is so far the only realistic way of satisfying the necessary requirements. The high safety level of nuclear installations, which do not burden the living environment with unfavorable exhalations, is an additional argument which speaks in favor of the development of nuclear power.

The Cost of One Megawatt

A nuclear electric power plant is now in operation in Czechoslovakia: the V 1 in Jaslovske Bohunice. It has two VVER 440 reactors. Its second part, V 2, again with two VVER 440 reactors, is under construction. A nuclear electric power plant with four VVER 440 reactors is under construction in Dukovany, and work has begun on the nuclear electric power plant in Mochovce. Preparatory work is being done on the construction of the first nuclear electric power plant with four VVER 1000 reactors in Temelin near Ceske Budejovice.

If we started to build at the present time a classic electric power plant of the same output, equipped with an efficient installation for desulfurization of combustion products and with reliable processes for removal of fly ashes, the specific investment costs could be derived as follows: about Kcs 6 million per megawatt for a classic electric power plant, and Kcs 3 million per megawatt for desulfurization. Of course, in the case of such an electric power plant we would also have to provide for the corresponding extraction of coal and its transportation. For 1 megawatt of installed output, this amounts to about 2,300 tons of specific fuel annually, which in terms of investment costs represents Kcs 4 million. And it is increasingly more demanding all the time, both in terms of technical and financial requirements, to continue increasing the extraction of coal.

If we add all these facts up, the total specific investment costs of a new classic electric power plant and the corresponding extraction and delivery of coal represent approximately Kcs 13 million per megawatt of installed output. And so, in terms of investment requirements, nuclear electric power plants are not more expensive than classic electric power plants using coal.

And what about production costs of 1 megawatt-hour of electric power delivered to the network? In the case of a nuclear electric power plant, they vary from Kcs 200 to 240 per megawatt-hour, in the case of a classic electric power plant without desulfurization they amount to about Kcs 200 per megawatt hour. Therefore, even from the viewpoint of production costs, the outlays for a nuclear electric power plant are roughly comparable to those of classic electric power plants.

If we take into consideration the fact that after 1990 there will be a gradual decline of the extraction of brown coal and also a decline in its calorific capacity and an increase in its sulfur content and the amount of fly ash, we can rearch the unequivocal conclusion that the future development of the national economy depends on successful construction of nuclear electric power plants, and also on the construction of nuclear thermal plants.

Nuclear Electric Power Plants and Supply of Heat

Nuclear electric power plants will also be used to supply thermal energy, particularly for heating. Deliveries of low potential heat for use in agriculture are also under consideration.

At the same time, basic output alone will be covered by nuclear resources. Semipeak production and peak production will be taken care of by local sources. Optimum deliveries of heat from a nuclear electric power plant vary about 40 to 50 percent of maximum output. Then, approximately 75 to 85 percent of annual heat consumption could be covered by heat obtained from nuclear electric power plants with heat consumption (JEOTs--"jaderne elektrarny s odberem tepla"), and the remaining 15 to 25 percent would be covered from local sources.

The condition for deliveries of heat from JEOTs and also from a nuclear heating plant (JV--jaderna vytopna) is that the customer's system is adapted for long-distance deliveries of heat produced almost exclusively in the form of hot water. A system of centralized supply of heat of an adequate capacity has to be created first in the corresponding customer systems.

One absolutely cannot agree with the view that a thermal feeder and a convertor station should be built first in a JEOT, and that only then they should be adopted gradually by a system of centralized supply of heat. Such view is erroneous, unrealistic, even in connection with preparations for deliveries of heat from classic electric power plants (using coal), which are being converted to partial operations as thermal plants. Local systems of centralized supply of heat must be also prepared in advance in these cases.

With regard to the nuclear electric power plants under preparation, namely the V-2 in Jaslovske Bohunice, JE in Machovce, JE in Temelin, and possibly JE in Dukovany, deliveries of heat are to be about 1,500 to 2,000 thermal megawatts:

--by 1990 from the JE V 2 Jaslovske Bohunice--about 200 megawatts;

--by 1995 from the JE V 2, JE Mochovce, JE Dukovany, and JE Temelin--about 600 to 800 megawatts;

--by the year 2000 from the given nuclear electric power platns--about 1,000 1,200 megawatts.

These outputs are lower than the figures contemplated in research and project studies. Naturally, any increase of deliveries of heat with a high annual use of the installed output will be very useful. The nuclear electric power plants have much greater capacities. Of course, heat consumption does not depend only on the nuclear source, but also on the consumer of heat, his requirements, and on the capacity and opportunity to get adjusted to the conditions of the consumption of heat obtained from nuclear electric power plants.

About Conversion of Classic Electric Power Plants

The problems of conversion of classic electric power plants to partly thermal operations involving delivery of heat is similar in some respects to conversions of nuclear electric power plants. For example, delivery of steam cannot be eliminated entirely in view of the present systems of heat supply, but of course priority will be given to hot-water systems. The specific investment costs of the conversion of an electr c power plant, including a thermal feeder, are between 1 and 2 millions per megawatt. In the case of thermal power plants, including thermal feeders, the amount is Kcs 3 to 3.5 million per thermal megawatt.

However, we shall not provide thermal heating of areas by nuclear electric power plants alone and by conversion of classic electric power plants to partially thermal heating operations. That is why in the near future, approximately after 1990, it will be necessary to provide for deliveries of heat from nuclear heating plants for the benefit of some places with high concentration of housing constructions and industrial production.

Contribution of Nuclear Thermal Heating Plants

The first JV is being planned for the Ostrava-Karvinna agglomeration. It involves a Soviet AST 300 nuclear thermal heating plant with an output of 2 x 300 megawatts and the possibility of expanding it by adding one more block of 300 megawatts, which means an output of as much as 3 x 300 megawatts. In the long run, it may be possible to use a nuclear thermal heating plant for additional agglomerations, such as for example Prague, Kosice, and so on, unless priority is given to nuclear electric power plants near these localities.

The estimated investment outlay for a new thermal heating plant of Soviet AST design 2 x 300 megawatts is about Kcs 2.8 billion, which means Kcs 4.67 million per megawatt. In the case of the Swedish SECURE design 1 x 200 megawatts, for example, the amount is approximately 1.2 billion, which corresponds to Kcs 6 million per thermal megawatt. And the overall collective outlays for a thermal plant using coal amount to Kcs 4.3 million per thermal megawatt. This comparison shows that investment requirements for a nuclear thermal heating plant are not significantly higher as compared to classic sources of heating by thermal plants (heating systems). Of course, we expect that the production costs in the case of a nuclear thermal heating plant will be significantly lower. Also, we have to start on the basis of the fact that nuclear thermal heating plants will replace not only the classic sources of thermal heating, but also sources which use heating oils or natural gas. One can state, on the basis of economic studies by the Federal Ministry of Fuels and Power and by the Czechoslovak Commission for Atomic Energy, that the so-called converted costs of heat deliveries from nuclear sources in the year of 2000 will be about Kcs 80 per GJ /gigajoule/, and from classic sources of het approximately Kcs 140 per GJ.

The overall specific investment outlays for a classic electric power plant using coal and equipped with installations for desulfurization of the products of combustion, including the corresponding extraction and transportation of coal, are not lower at present than investment outlays for a nuclear electric power plant. Safety of nuclear sources also keeps increasing, nuclear electric power plants have an incomparably more favorable effect on the ecology of both nearby and distant environments as compared to classic electric power plants. Facts demonstrate clearly a need for orientation to nuclear power.

5668
CSO: 5100/3006

BRIEFS

SUCCESSFUL NUCLEAR REACTOR TEST--Rez, 20 Dec (from our correspondent)--On Sunday, 19 December 1982, at 1947 hours, the experimental nuclear reactor LF-0 [expansion unknown] at the Nuclear Research Institute at Rez was brought, for the first time, to critical mass as part of actual operations. The employees of the institute and the enterprise Energeticke Strojirenstvi [Energy Engineering] of Skoda Plzen have thus achieved a significant stage in the joint socialist contract accepted in honor of the 10th Trade Union Congress to finish, undertake a complete testing and, after a trial run, start the actual process of trial operations in the beginning of January 1983. In the future, we will be able to obtain important information about ways to increase security and reliability of the nuclear power reactors and the efficiency of its operations. The research will also contribute new findings to the Czechoslovak engineering which is developing the production for the nuclear power and, consequently, will enrich the international cooperation of the socialist countries in this area. [Text] [WA111000 Prague RUDE PRAVO in Czech 21 Dec 82 p 1]

CSO: 5100/3009

BRIEFS

FIGUEIREDO DECREES NUCLEAR RESEARCH MONOPOLY--A decree signed by President Figueiredo establishes a federal government monopoly on the development of research in the nuclear energy field. The scientific community had been expecting this decision by the government after the recent transfer of the Sao Paulo Atomic Energy Institute to federal control. According to the decree, any institution will be able to carry out research in the nuclear field, but only through an agreement with the National Nuclear Energy Commission. [Text] [PY301408 Sao Paulo Radio Bandeirantes Network in Portuguese 1000 GMT 30 Dec 82]

NUCLEAR PLANT BUILDING SUSPENDED--After profound meditation and taking into account the crisis that the country is experiencing, President Figueiredo has decided to suspend the construction of the Iguape One and Two nuclear plants. The plants were to have been built on the seacoast south of Sao Paulo as part of the Brazil-FRG nuclear program. Nuclebras has already received the presidential directive that will remain in effect until our economy and the world crisis improve. [Excerpt] [PY071452 Sao Paulo Radio Bandeirantes Network in Portuguese 1000 GMT 7 Jan 83]

CSO: 5100/2023

COMMISSION DENIES NUCLEAR CONTAMINATION

PY111559 Santiago Domestic Service in Spanish 1000 GMT 11 Jan 83

[Text] The Chilean Atomic Energy Commission has termed as alarmist rumors of a nuclear contamination of the country. In this regard, Col (Juan Munoz Dupois), executive director of the Nuclear Energy Commission, has issued the following official statement:

In view of recent reports of an alarmist nature regarding the existence of nuclear contamination in Chilean waters the Nuclear Energy Commission declares that:

This organization has established a national program to measure radioactivity in the environment. This is carried out through a national network of nine stations established in the cities of Arica, Antofagasta, Eastern Island, Coquimbo, Santiago, Concepcion, Temuco, Puerto Montt and Punta Arenas.

The document then states that the Nuclear Energy Commission measures radioactivity on the basis of the level periodically established by the International Nuclear Energy Agency (IAEA) headquarters in Vienna. The measurement is made from samples of air, rainwater, seawater, drinking water, natural milk, processed or pasteurized milk, vegetables, fish, meat and other products.

It is also disclosed that in order to correctly determine the level of radioactivity in the environment the measurement taken must be compared with the corresponding maximum evel accepted by the IAEA.

CSO: 5100/2022

ADVANCED NUCLEAR STUDIES REQUIREMENTS NOTED

Havana GRANMA in Spanish 18 Nov 82 p 3

[Text] The process of applying for advanced nuclear studies as a major field of specialization has already begun in all the college preparatory institutions in the country. The requisites for the applicants are the following:

Grade average of 95 points or above in grades ten and eleven; grades higher than 95 points in mathematics, physics and chemistry in grades ten and eleven; maintenance of satisfactory social behavior and a good attitude toward studying and students' tasks.

The young people that meet these requirements will be able to apply to the Admissions Committee of their college preparatory institution for the fields of specialization to be studied in Cuba as well as abroad.

The Provincial and National Vanguards must submit their applications and survive the selection process as provided in Resolution 55/80 of the Ministry of Higher Education and in Instruction 4 of 1981 in order to choose nuclear studies as a field of specialization.

The processing of applications will end on 5 December.

9907
CSO: 5100/2017

DELHI MOVES TO RAISE URANIUM OUTPUT REPORTED

Bombay THE TIMES OF INDIA in English 24 Nov 82 p 8

[Text]

NEW DELHI, November 23 (UNI).

INDIA proposes to increase uranium production to meet the increased requirement of India's nuclear power programme.

The state-owned Uranium Corporation of India (UCIL) has plans to expand and open two more deposits at Narwapahar and Turamdih, which are located in the mineral belt known as Singhbhum thrust belt of Bihar.

Besides the company will also open another deposit at Bodal in Madhya Pradesh, according to official sources.

Experts feel that India has an excellent potential for discovering new additional resources of uranium.

Feasibility studies for opening up of the deposits at Narwapahar and Turamdih have been completed and detailed development designs are under formulation.

Experience gained in operating mine and the mill at Jaduguda will be used to design improved lay-out and reduce the lead time between mining and milling.

India has established adequate resources of uranium to meet the country's requirements for its nuclear power programme. The estimated additional resources as on today stand at 67,000 tonnes of U-238 apart from some 13,000 tonnes contained in the monazite sands occurring along the beaches and inland deposits.

India's thorium resources are estimated at 363,000 tonnes of THO2.

Sufficient know-how has been developed for recovery of uranium as a by-product of copper. After establishing the economic feasibility for its recovery a uranium plant has been set up adjacent to the copper mine. It is proposed to set up similar plants at other copper mines, the sources explained.

The optimism for finding more uranium deposits is on the basis of the already known deposits occurring in various geologically-favourable host rocks which typify nearly all the recognised types of deposits in the world and in view of a large part of the country with favourable host rock still to be fully investigated.

Intensive exploration and drilling works have been taken up in some parts of northern Karnataka, Meghalaya and tertiary Siwalik sandstones in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. In these places significant uranium bearing horizons have been identified by the atomic minerals division.

Uranium in significant tonnage also occurs associated with large exploitable deposits of copper in the Singhbhum thrust belt of Bihar and some phosphate deposits in Uttar Pradesh. It is being recovered as a by-product during copper mining. There are also possibilities of striking calcrete type deposits in arid parts of western Rajasthan.

CSO: 5100/7031

NUCLEAR DEVELOPMENT IN MIDDLE EAST ASSESSED

Tel Aviv MADA' in Hebrew No 4, Jul 82 pp 198-199

[Article: "On Nuclear Energy and Nuclear Weapons in the Middle East"]

[Text] At a convention of nuclear associations which was held at the Technion in February 1982, prof Shimon Yiftakh lectured on the subject "Nuclear Energy Program in the Middle East". The lecture dealt with several aspects of nuclear development in this region, and their effect on Israel's considerations in the area of nuclear development plans and the possible operation of nuclear power plants.

The destruction of the Iraqi nuclear reactor "Osiraq" was characterized by the lecturer as motivated by self defense, because of the great danger involved in it for Israel, which he expalined at length in the article "The Iraqi Reactor and the Nuclear Threat to Israel".[1]) The question is to what extent will Iraq be able to reconstruct the damage which it suffered. Saudi financing has already been proposed, but will there be French agreement. In the mean time, thePrench are declaring that they will never supply 93 percent enriched nuclear fuel, but only 7 percent enriched fuel, which the Iraqis declined to accept in the past. It should also be understood that the Iraqis are thus denied the ability to produce Uranium 235 bombs, but not plutonium 239 bombs. At the same time it can be said that the immediate Iraqi nuclear threat has been postponed for two to three years.

At the far end of the Middle East, Pakistan is involved in the accelerated nuclear development. This development is presented primarily as a counterweight to Chinese and Indian nuclera development, and its purpose is to achieve an Asian balance of terror. Nevertheless, and in spite of the geographical distance (3000 km), Israel has great interest in this development. The nuclear program is presented as a program to achieve an "Islamic" bomb, and its financing is Islamic--impoverished Pakistan is being helped to finance this program by a number of Arab countries, headed by Lybia. Qadhafi, who is investing a lot in the Islamic program, is interested in the first bomb in exchange for his generous contributions.

The Islamic nuclear program began in 1972, and received a boost after 18 May 1974, when the Indians conducted a plutonium 239 explosion, with a force of 15 kilotons. Pakistan is trying to advance on two roads possible for the development of a nuclear bomb; with uranium 235 and with plutonium 239.

As for the uranium 235 method, this is being done at a centrifuge plant in Kahuta, near Islamabad. The construction of this plant is tied to a story of industrial espionage. The "spy" is the director of the plant, Dr Abd-el-Qadi Khan. Between the years 1972 and 1975, he worked for a Dutch engineering firm--FDO. This company had a close working relationship with a partner plant in Britain, West Germany, and Holland, for centrifugal enrichment, located in the city of Almelo, and called Urenco. Abd-el-Qadi Khan was lent to this plant for a number of weeks, to help in technical translation. During this period he freely toured the plant, and even later continued to gather information and to photograph blue prints. When he had learned enough he went on holiday with his family, and he has never returned to Holland. The information about what is going on in this area in Pakistan comes mainly from India, which closely follows nuclear development in Pakistan. According to Indian sources, the plant in Kahuta is working within a special security framework, and is built on the model of the Manhattan project, which built the atom bomb in World War II.

Another important plant is the plant at Chasma, for separating plutonium. This plant was purchased in France in 1973, and was supposed to process 100 tons of radiated fuel per year. From this can be produced about 80 kg of plutonium per year, a quantity sufficient for 12 nuclear bombs.

Officially, work on the project in France stopped in 1978, due to American pressure, but its accretions continued into 1979. Some of the production was transferred from the French company to a wholly owned Italian company.

In addition to the Kahuta and Chasma plants, Pakistan has the following installations: a natural uranium-heavy water plant, supplying 135 megawatts of electricity (400 thermal megawatts) called Kanopp, which was purchased from Canada and set up near Karachi in 1973; an installation for producing fuel units for power reactors; an enrichment facility in Sihala; an experimental separation facility, supplying 8 to 10 thermal megawatts. It is also known that there are hundreds of tons of natural uranium in Pakistan, transferred from Nigeria by way of Lybia.

As for treaties and international supervision, Pakistan is not a signatory of the nuclear non-proliferation treaty. For the Kanopp reactor, there is a supervision contract with the International Atomic Energy Agency. At this reactor it is possible to produce about 70 kg of plutonium per year, or 10 nuclear bombs. According to the report of the directof of the International Atomic Energy Agency of September 1981, the agency cannot verify that there have been no diversions of nuclear fuel for non-civilian purposes, since Pakistan has been producing, with its own facilities, nuclear fuel for the reactor. Pakistan has refused to alter the supervision procedures.

The declared program of Egypt is to achieve, by the year 2000, the operation of eight nuclear reactors, which will supply 40 percent of its electricity. Last year, Egypt signed agreements with France in this area, as well as the U.S., Britain, and Canada. For this purpose, Egypt signed the nuclear non-proliferation treaty on 16 February 1981. If this target is reached, Egypt will acquire much basic technological knowledge in the area of independent production.

The decision to supply reactors to Egypt has eased the process of acquisition by Israel of similar technology.

As for the position of Israel in the area of nuclear reactors, it appears that there may be a turnabout which will enable us, if we wish, to build a nuclear reactor by the end of the 1980's. The turnabout stems from a chnage in American policy. President Reagan wants to restore nuclear leadership to the U.S., to make it easier to build such reactors in the U.S. and te export them to other countries.

In October 1981 there was published a policy declaration, in which the secretary of energy was directed to deal, with immediate priority in the improvement and easing of nuclear licensing. The goal is to reduce by a number of years the licensing process. This reduction has far reaching significance, because the protracted process of licensing was a decisive factor in the increase in the price of construction. This reduction will also lead to a similar reduction in other countries.

A second directive of the president calls for the continued construction of breeder reactors, which had ceased during the Carter administration. A third directive: ending the ceassation of recycling nuclear fuel to produce plutonium, which can be used as fuel for breeder reactors, and the encouragement of the private sector to enter this area. A fourth directive: accelerated handling of the problem of disposing of radioactive waste.

The administration is working to weaken the force of regulations in the area of licensing, nuclear exports, and nuclear supervision of purchasers from other countries. The president authorized the sale of nuclera fuel to India, which is not a signatory of the nuclera non-proliferation treaty. It also authorized great financial aid for Pakistan. In this spirit, it is possible that the freeze will be broken, which had taken place in the days of Carter, regarding the supplying of two reactors of 900 megawatts each to Israel.

If Israel will obtain two reactors having an output of 1800 megawatts of electricity, there will be a saving in oil on the order of the output of the Alma field before its additional development. According to prof Yiftakh, the building of these reactors is essential, both because of the saving in foreign exchange, as well as the reduction of dependence on fuels from distant places. In his opinion, we should exploit the great interest of reactor producers in building reactors, in order to build 3 or 4 reactors in Israel by the end of the century. The trend of the American administration to ease the limitations on nuclear energy will make it easier for Israel in this area. In short: the lecturer thinkgs that building atomic reactors is in the urgent interest of Israel.

7075
CSO: 5100/4501

CRITICISM OF COUNTRY'S NUCLEAR POLICY REFUTED

GF021327 Islamabad THE MUSLIM in English 21 Dec 82 p 4

[Editorial: "No Compromise on Nuclear Program"]

[Text] Despite all the effusiveness demonstrated by our powerful friends across the Atlantic and the facade of goodwill maintained by those on this side of that expansive ocean, there appear to be a few hidden hands determined to foil Pakistan's efforts to acquire the necessary technology and material needed to operate this country's nuclear facilities. And that in spite of our avowed objective to develop technology to meet the nation's energy needs. President Zia has repeatedly been trying to dispel any misgiving that might be lurking in any quarter of the world that Islamabad may secretly be trying to steal into the nuclear club by hammering in the assurance that we have no desire whatsoever to produce atomic weapons. And yet, a BBC report appearing in the press on Friday said that the director general of the International Atomic Energy Agency (IAEA) had observed at the end of his visit to New Delhi that he was not fully satisfied with the arrangements made by Pakistan to prevent fuel from its nuclear power stations being used in the production of nuclear weapons.

It is ironical that the IAEA chief should have made this comment on the eve of his departure from a country which had already exploded a nuclear device, and was well on its way to join the ranks of nuclear powers. What exactly the director-general of the international agency meant by his statement that this country had agreed to some safeguards but was still to agree to others, is not known to us. If this reference was to the additional safeguards desired only to be forced upon Pakistan, while this insistence was not being made applicable to others, we can only invite his attention to President Zia's statement made in the course of an interview given to UPI towards the end of the last month. He had said that when India, Israel, Japan, South Africa and Brazil with their nuclear potential were not being pressurised, he would not accept additional safeguards if only Pakistan was singled out for this discriminatory treatment. But if the same yardstick were to be used in the case of every country which was nuclear installations, Islamabad would, in fact, even accept more safeguards than the others.

President Zia reiterated his commitment to pursue Pakistan's peaceful nuclear programme geared to produce the much needed energy for rural electrification and to expand the country's industrial base. He said in Toronto only the other day that his government was determined to acquire nuclear technology and said that he had made this position clear to the Canadian leaders during his talks in Ottawa. If Pakistan could not acquire nuclear technology through cooperation, he firmly asserted that it would develop that technology through indigenous means. We have enough uranium and are not without the technical know-how. To the Canadian offer made by its administration officials that Canada would resume supply of fuel and spare-parts for the Karachi reactor if Pakistan signed the non-proliferation treaty, President Zia told newsmen in Toronto that Pakistan would do so if India also signed the treaty. No one in this country would want Pakistan to compromise the country's self-respect by meekly accepting a unilateral all discriminatory decision that is sought to be enforced on us.

CSO: 5100/4324

INDIA DENIES PLANS TO ATTACK PAKISTANI NUCLEAR FACILITY

BK201658 Delhi Domestic Service in English 1530 GMT 20 Dec 82

[Text] An official spokesman in New Delhi has described as totally false and unfounded a WASHINGTON POST report suggesting that there were plans for a preemptive attack by India on Pakistan's nuclear reprocessing facilities. The report quoted U.S. intelligence sources to say that the such a plan had been suggested by Indian military officers to the prime minister.

The spokesman characterized it as a figment of someone's imagination and absolute rubbish. On the contrary, India and Pakistan are engaged in a very serious exercise for bringing about a rapprochement between them, he said. Pakistan's Foreign Secretary Niaz Naik is visiting New Delhi on Wednesday, [22 December] for finalizing the modalities of functioning of the Indo-Pak joint commission which has already been set up in principle. We expect that an agreement on the joint commission will be initialed during the forthcoming talks, he said. The talks to be held on Thursday and Friday will also cover Pakistan's proposal for a nonaggression pact and India's proposal for a treaty of peace, friendship and cooperation.

CSO: 5100/4316

STUDY ON NEED FOR ADDITIONAL NUCLEAR POWER PLANTS SOON READY

Helsinki HELSINGIN SANOMAT in Finnish 14 Dec 82 p 29

[Text] Imatra Power Company (IVO) manager Kalevi Numminen told us that in March the IVO will have a report ready in which the construction of two approximately 500-Mw nuclear power plants is examined as an alternative to the 1,000-Mw plant that had been planned for Finland.

According to Numminen, the Soviets offered two 480-Mw power plants as an alternative to one big one last January at the time of the delegation headed by general manager Ahti Karjalainen's visit. As for the IVO, it began studies relating to this offer at once in February.

"Technically speaking, we have nothing against these small power plants. On the other hand, the cost per kilowatt-hour of producing electricity is lower with one big plant than with two small ones," Numminen said.

This attitude represents some sort of change in IVO's way of thinking. Namely, the firm's retired manager, Pentti Alajoki, spoke strongly in favor of smaller plants in his time.

No Pressures to Raise Price of Electricity

According to Numminen, the actual cost of electricity is about the same this year as in 1965 and there is no pressure in sight now to raise the price of it either. He emphasized the fact that this lowest possible price of electricity is especially due to conditions in the lumber and other export industries. "Since the competing price of Swedish electricity is about a fourth less than ours, we cannot really afford to raise the price," Numminen noted.

Numminen further emphasized that stable development of the real cost of electricity requires an even-tempered energy policy. "This also includes making future decisions on the most economically profitable basis," he said.

IVO Operations Increased by Over 12 Percent

The IVO's total activity involving electricity during the year that is ending is estimated at 18.9 twh (terawatt-hours = billions of kilowatt-hours). The increase in total activity since 1981 is 12.2 percent. This big increase is

fairly large amount of energy because of favorable water conditions. So-called firm sales based on long-term agreements increased 5.7 percent.

The company's income from the sale of electricity in 1982 is estimated to be 3.407 billion marks, whereas it was 3.104 billion marks last year.

Of this electricity, 42 percent was produced by nuclear power, 41 percent by water power and 13 percent was imported from the Soviet Union, so that little imported fossil fuel was needed (coal 3 percent, natural gas 1 percent and no oil at all).

"The 1982 situation for the entire country is apparent. Consumption is about 42 twh, which means a 1.8-percent increase in comparison with last year. Since the national growth rate was lower than the increase in IVO sales, the company's share of the market, which is now 41.2 percent, grew somewhat," Numminen said.

In 1983 600 Mw of electric power will be imported from the Soviet Union for almost the whole year with the exception of holidays and the long daylight hours of the summer season. The direct current link between Finland and the Soviet Union will be completed by fall of 1983.

"During peak load periods we have to get a price for electricity from Sweden that corresponds to the cost of producing coal condensate. Because of this, before coal condensate production is set in motion, some electricity will probably be purchased from Sweden too," Numminen noted.

According to Numminen, the chances of economically selling electricity to Sweden in terms of current price structures are slim.

IVO Begins Production of Remote Heat

During the year now ending, the IVO also began to be a supplier of remote heat when one machine was converted into a remote-heating machine at the Naantali condensation power plant and a hot-water tunnel between Naantali and Turku was completed. Thus the coal plant already in existence in the 1960's is now providing heat for Turku, Raisio, Naantali and Kaarina. The same sort of conversion operation will be completed at the end of the year in Hameenlinna when the Vanaja power plant, which is even older than the one at Naantali, resumes operation and provides Hameenlinna with remote heat.

During the current year plans have been drawn up for remote-heating plants at Jyvaskyla and Joensuu. They are designed to run on peat. When the plants are completed in 1986, the IVO will become Finland's biggest consumer of peat.

11,466
CSO: 3100/2534

BRIEFS

LOVISA 1 PLANT HALTED—Lovisa (HS)—On Monday a recurring defect in the main circulation pump seal halted operation of Lovisa's 440-Mw number-one plant. During the shutdown, which will last for about a week, the whole circulation pump will be replaced because of the irregularly functioning seal. Lovisa's number-two plant is also shut down at the present time because of annual maintenance. It should go back into operation about the end of the year. The shutdown of Lovisa's second plant also set in motion the Inkoo coal power plant where two 250-Mw generators were put into operation on Monday. Plant manager Erkki Mikkola said that they have been in a state of readiness for about a year now. Altogether three generators are now in operation at Inkoo since one of the four generators has been used in the daytime these past few weeks. By means of a so-called adjustment run, they have been trying to test and correct performance in terms of how peak consumption needs can be satisfied when the plants' capacity is insufficient to meet basic load needs. One of the Inkoo generators is still waiting, ready to go into production. According to plant manager Erkki Mikkola, the setting in motion of electricity production at Inkoo is, among other reasons, important from the standpoint of job motivation, that is, plant personnel have had jobs during a state of readiness too, but such work has not been productive. With the arrival of winter frosts soon, in the nuclear power sector they are now relying on the Olkiluoto Teollisuuden Voima Oy (TVO) [Industrial Power Company] plants, both of whose 660-Mw generators are operating at full capacity. [Text] [Helsinki HELSINGIN SANOMAT in Finnish 14 Dec 82 p 8] 11466

LOVISA 2 PRESSURE CHECK—Lovisa (HS)—The latest inspection of the condition of the pressure vessel at Lovisa's number-two plant, which has been in operation for over 2 years, shows that it has remained unchanged. To be sure, the analysis of the data obtained during the inspection is still in part incomplete. Welding defects in the stainless steel inner layer of the pressure vessel have constituted the problem at Lovisa 2. Regarded as significant from the standpoint of safety, the defects were repaired before the plant went into operation. Imatran Voima [Imatra Power Company] constantly checks on the condition of the pressure vessel. In operation and now halfway through its 2-month-long annual maintenance, the Lovisa-2 reactor was taken apart and the inner layer of the pressure vessel was inspected with special West German Kraftwerk Union equipment. "With the reinstallation, the inspection took 2 weeks. The job was done in three shifts and was finished on Thursday morning," licensed technician Antero Tamminen of the IVO said. Some of the data obtained during the

inspection has not yet been analyzed, but, according to the data that has been so far, no signs of any changes have been found in the welding of the inner layer of the pressure vessel. In view of these findings, Lovisa 2 will probably be able to go into operation at the end of the year as scheduled. The next inspection of the same magnitude may be made in 4 years time. Inspection of the pressure vessel requires that the reactor be disassembled, which prolongs the normal annual maintenance time. Normal annual maintenance takes about a month and a large-scale operation, which has to be performed every 4 years, about 2 months. "Lovisa 2's so-called break-in period problems now seem to be over," Radiation Safety Institute acting director Tapio Eurola said. Since the operational life of a nuclear power plant is calculated to be 30 years, both Lovisa 2 and Lovisa 1, which has been in operation for about 5 years, are still young plants. [Text] [Helsinki HELSINGIN SANOMAT in Finnish 4 Dec 82 p 11] 11466

CSO: 5100/2534

URENCO EXPANSION SEEN AS PROLIFERATION DANGER

Rotterdam NRC HANDELSBLAD in Dutch 2 Dec 82 p 7

[Article by W.A. Smit, director of the Center for Questions of Science and Society "De Boerderij" of the Twente Institute of Technology, B. Elzen, a scientific associate and P. Boskma, a professor of philosophy and technology in that institute: "Urenco [Uranium Enrichment Company] Expansion Increases Proliferation Danger"]

[Text] Urenco, the Netherlands-English-FRG consortium for uranium enrichment has concluded an agreement in principle with Australia for the construction of an enrichment plant in that country, on the basis of UC [Ultracentrifuge] technology. What does this export of UC technology mean for the nonproliferation effort?

Until about 1975, plutonium produced in the civilian application of nuclear energy was considered by far the most important channel for the further spread of nuclear weapons. However, as a result of an increase in the number of enrichment plants, a second channel was recognized as possibly just as important, namely the production of highly enriched uranium. Besides, that is regarded as a shift to technologies more sensitive to proliferation. For example, an ultracentrifuge enrichment plant can be converted in a short time to the production of highly enriched uranium. Thus in contrast to the "old" gas diffusion technology, which, for example, was used by the United States, the Soviet Union and France.

One could point out that the problematic nature of UC technology itself, from the proliferation viewpoint, is compensated for by Urenco's multinational setup; a framework which according to An Salomonson (NRC HANDELSBLAD, 11 Apr 1982), "offers the best guarantee, that abuse for military purposes is excluded through mutual control."

Moreover, the expansion of this multinational basis with Australia would be very attractive for the Netherlands, because of the strict Australian nonproliferation attitude.

However, as an instrument of nonproliferation policy, the present multinational framework of the Urenco "exhibition model" is considerably less ideal than An Salomonson assumes.

In general, a multinational enrichment consortium must meet at least the following conditions from a nonproliferation standpoint.

1. It must not operate more than one plant;

2. The plant must be under IAEA [International Atomic Energy Agency] control, with the regular presence of inspectors to be able to confirm immediately the possible withdrawal of fissionable material or the clandestine production of highly enriched uranium;

3. The participating countries must be bound by an agreement without an escape clause so that beginning "for one's self" is not allowed;

4. The participating countries may not, besides, enrich uranium on a national basis, regardless of the technology applied. Research and development would also only be allowed within the framework of the multinational organization. No support may be given to other countries in the construction of a national plant.

5. The enterprise may not produce any highly enriched uranium.

Own Plants

Urenco is not meeting these conditions in many respects.

Regarding 1 and 3. Each of the Urenco partners has its own plant. Moreover, the German plant is located on Dutch territory, but the FRG began this year the construction of a plant on its own territory, with the agreement of the Netherlands. Since 1980, according to the VvA [Almelo Agreement], the three countries can withdraw from the cooperative association, with a cancellation period of a year. If the three should break up, for example, because of disagreement about the nonproliferation conditions to be specified for delivery of enriched uranium, then each of the three countries has a national enrichment industry available, an extremely undesirable situation. The fact that this danger is not imaginary appears from the dispute about

the delivery conditions to Brazil which has led the three to the edge of the abyss; moreover, the supervision stipulated by the Dutch Parliament has meanwhile become invalid, now that Urenco does not let the Brazilian delivery take place from Almelo, but from the English enrichment plant.

Regarding 2, about the way in which the IAEA shall take over the safeguarding now done by Euratom, this is still being negotiated. However, the necessary regular use of inspectors will almost certainly not be achieved.

Regarding 4, the VvA promises to offer each of the partners for joint execution and exploitation the research and development projects undertaken regarding the UC process and the results obtained from this. If the other partners do not wish to participate, then the initiating country can continue on a national basis. Enrichment methods with other technologies (such as jet nozzle in the FRG and gas diffusion in England) are outside the scope of the multinational cooperation.

Regarding 5, the VvA does not forbid the nuclear weapons country England to use the UC method (outside the Urenco association) for the production of highly enriched uranium for military purposes. England is now proceeding towards this (see the Volkskrant of 18 August 1982). According to the VvA, the Netherlands and the FRG may also produce highly enriched uranium, provided it is not for nuclear weapons (but certainly for other military purposes).

It is clear that there is something wrong with the Urenco multinational "exhibition model." The fact that the development of UC technology is problematic in itself, from the nonproliferation viewpoint, is certainly not compensated for by Urenco's organizational structure. As regards that, the operation of uranium enrichment under an international control would be preferred by far over a number of multinational enterprises (such as Urenco and Eurodif [expansion unknown]) which rather unavoidably develop a mutually competitive relationship. By cooperating with Australia, the Australian uranium supplies can, moreover, perhaps give Urenco a strong starting position with respect to competition; however from the nonproliferation standpoint, every expansion of the number of enrichment plants in the world must be regarded as undesirable. The delivery of technology to Australia undertaken is, besides, additionally undesirable as that country would operate the plant on a national basis, but it is likewise undesirable, from a nonproliferation standpoint, when that would take place through such an imperfect association like Urenco.

Careless

After the Kahn affair in which, through Dutch carelessness, Pakistan was able to steal UC technology from Almelo and after which Dutch plants, among other things, delivered necessary materials to Pakistan, the Netherlands with this trade in UC technology again rendered a poor service to the nonproliferation efforts.

Although we do not doubt the sincerity of the Dutch effort to prevent further proliferation of nuclear weapons, we are of the opinion that with the export of UC technology to Australia rather the opposite will be achieved. If the Netherlands wants to give more emphasis to its nonproliferation efforts, then it would have to direct its policy to the fulfillment of the five above mentioned conditions, which, among other things, maintains that the number of enrichment plants would have to be reduced to one and not as it now appears, be expanded to four. It would be better still to put this plant under international, instead of national supervision, which offers a better guarantee for control.

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CSO: 5100/2532

OVERVIEW OF NUCLEAR POWER, RESEARCH ACTIVITY

Madrid ENERGIA NUCLEAR in Spanish Sep-Oct 82 pp 327-340

[Lecture delivered on 3 September 1982 at Menendez Pelayo International University, during the course on "The Environment and Energy," by JEN member Manuel Lopez Rodriguez: "Spanish Nuclear Energy Situation"]

[Text] 1. Introduction

In the early 1960's, the then Spanish Ministry of Industry (now the Ministry of Industry and Energy) was actively concerned with beginning a development program that would allow for the incorporation of nuclear power into the national electric supply. The fact that the country had very limited supplies of primary energy resources and, on the other hand,the situation whereby the economically usable hydroelectric potential would be depleted within a fairly short period of time, constituted sufficient reason for becoming geared to the use of nuclear power.

Moreover, as in the case of other countries with considerable energy dependence, Spain is an example of meager balance between the supply and demand for energy, and hence has a small margin of flexibility.

At that time, Spain had an authorized technical agency, the Nuclear Energy Board, created by a decree-law of 22 October 1951, which had at its disposal, after 1958, a research center in Madrid, a group of mining sectors distributed all over the national territory in which radioactive ores were being prospected for and exploited, and a factory for the production of uranium concentrates, in Andujar (Jaen). And it was to this agency that the government entrusted the preparation of the studies aimed at devising a first nuclear development program, consisting of the building of three powerplants with a total power of 1,100 MW.

2. The First Spanish Nuclear Powerplants

The Nuclear Energy Board, in cooperation with the Ministry of Industry's technical entities, analyzed the advantages and disadvantages that would stem from basing the program on the construction of analogous units, or from using different nuclear techniques, finally opting for the latter, with the view that nuclear technology had not attained a sufficient definition, and that it was advisable to pursue the various trends which might be subjected to commercial applications.

Acting in favor of the adoption of a generation technique using natural uranium was the greater simplicity of the fuel cycle, and the possibility of nationalizing all its phases; on the other hand, the enriched uranium technique had advantages in the cost of installation and also in the final cost of the power. The latter fact prompted the decision to initiate the nuclear program with one powerplant based on enriched uranium and pressurized water, followed by another based on enriched uranium and boiling water and a third based on natural uranium.

The development of a nuclear program for a country possessing only moderate technical and economic resources is a herculean task, requiring the adoption of certain prior measures of a legal and administrative nature to guide it. For the foregoing purposes, the government sent the Cortes a bill on nuclear energy, which was passed in April 1964, and which constituted the main instrument for the nuclear planning in Spain. This law assigned the authority in the field to the Ministry of Industry, in order to establish unity of management, citing as a principal mission of the Nuclear Energy Board that of advising this Ministry in the area of nuclear power, also bearing direct and executive responsibility in matters relating to the nuclear safety of the facilities.

In June 1964, based upon the aforementioned legal instrument, authorization was granted for the construction of the first nuclear powerplant (Jose Cabrera, 160 MW, PWR), located in the province of Guadalajara, its operator being Union Electrica, S.A. [Electric Union, Inc]. Subsequently, in May 1966, authorization was given for the second nuclear powerplant (Santa Maria de Garona, 460 MW, BWR), in the province of Burgos; and, in 1968, the program was completed with the authorization for the third one (Vandellos-1, 500 MW, GC), in the province of Tarragona. At the present time, these three powerplants are in service and are operating normally, supplying power to the national electrical market with a high degree of utilization.

The experience gained in this first nuclear program made it possible to move to the actual application phase, through a second generation of powerplants that would afford a supply in 1980 (as it was thought at the time) of 8,000 nuclear MW, and in 1985 a supply of 24,000 MW. In this way, Spain would achieve an improved and flexible system for producing electric power, wherein the installed nuclear power would provide the basic power, and the hydraulic powerplants, owing to the ease of their regulation, would allow for a gearing to the daily fluctuations in demand.

As we shall observe later, this program was not carried out, because in 1982 Spain has only 2,050 installed nuclear MW at its disposal, and it is not likely that the 8,000 MW can be attained before 1985 or 1986.

3. Creation of the Coordination Committees

When the first Spanish nuclear powerplant was authorized, there was no awareness of the large number of problems that would crop up during its construction; and, for this reason, consideration was given to the feasibility of creating a fulltime coordinating entity that would make it possible to cope with the difficulties which might arise when the authorization was implemented and, in any event, to advise the General Directorate of Energy on the method for bringing up and resolving the questions that could bring about delays in the execution of the project.

The Ministry of Industry's order of 24 June 1964, whereby Union Electrica was authorized to build the first nuclear powerplant, indicated the period of execution and the inspection work to be carried out by the representatives of the Ministry of Industry and the Nuclear Energy Board during the construction, prohibited making substantial changes in the project and imposed a minimum of 40 percent for the national contribution to the construction of the equipment.

It also assigned the General Directorate of Energy to set up a Coordination Committee, with the mission of studying the details of the execution, the national participation and the general program of tests and checkups to be carried out during the construction and installation.

The General Directorate of Energy's resolution of 2 May 1966, which authorized Centrales Nucleares del Norte, S.A. [Nuclear Powerplants of the North, Inc] (NUCLENOR) to construct the second nuclear powerplant in the vicinity of Santa Maria de Garona (Burgos Province), reiterated virtually the same conditions stipulated for the Jose Cabrera powerplant, and added two others. So that there could be better control of the national participation, NUCLENOR would be required to demand of the leading supplier the suitable guarantees that would insure fulfillment of the established percentage, namely, 39 percent, and to submit to the General Directorate of Energy a detailed list of the awards of equipment and construction work to the Spanish companies that were to participate in the construction of the powerplant.

Finally, the General Directorate of Energy's resolution of 21 June 1968, which authorized the Sociedad Hispano Francesa de Energia Nuclear, S.A. [Franco-Spanish Nuclear Energy Company, Inc] (HIFRENSA) to construct the third nuclear powerplant in Vandellos (Tarragona), introduced a different aspect. Since there was no agreement in the previous talks between the administration and the operating firm on national participation in the construction of the powerplant, this resolution included a clause whereby the importing of goods, services and commodities of foreign origin would be subject to the standard regulation stipulated in Article 10 of the Law on Planning and Protection of Industry, of 24 November 1939.

Subsequently, and in view of the advantageous terms of the external financing offered, the minimal percentage of national participation in the construction was limited to 35 percent; despite the fact that it involved a more massive nuclear technique and one that was less complex in the main design.

The Coordination Committees, in addition to seeing to it that the project is carried out in accordance with the authorization granted, or proposing changes therein to the administration, allow for great speed in solving the many problems which crop up during the execution of the work, during the tests or during the operation of the powerplant. The small number of persons belonging to the committees affords constant contact among all their members, who are closely monitoring the progress and effects of the powerplant.

4. Change in the Spanish Participation

In 1957, studies were begun in Spain aimed at ascertaining the national industry's capacity for participating in the different phases of construction of a nuclear

powerplant. The Nuclear Energy Board, the Spanish firms constructing capital goods, the national engineering firms and a few foreign companies cooperated in these studies.

As a result of these studies, it was possible to establish the minimal percentage of national participation in the first three nuclear powerplants. In Table I, the participation actually attained in these powerplants, which are currently in operation, may be observed, ranging between 40 and 44.5 percent. These powerplants were contracted for on a "turn-key" basis.

For the second generation of nuclear powerplants, including those currently in an advanced stage of construction and the last one to go into operation (Almarar-1), the "turn-key" contracting has been abandoned, and the electric companies bear direct responsibility, based on a supply of the steam generation nuclear system as a whole, the turbogenerator and the rest of the plant. Thus, two contracts are established: one for the steam generation nuclear system, and another for the turbogenerator; contracts which can be made with the same supplier (as has been the case up until now) or with two different suppliers; with the electric company, in more or less extensive cooperation with a Spanish engineering firm (and the participation of a foreign one, in a small proportion) taking charge of the portion related to the rest of the plant, as well as the overall engineering thereof.

This type of contracting, which fosters national participation, was supplemented with a promotion of the Spanish industry, apprising it of the components which make up a nuclear powerplant, the features thereof, and the conditions that must be met, especially in the new area of quality guarantee. Along this promotion line, in early 1971 the Nuclear Energy Board prepared a document entitled "Requirements of the Nuclear Powerplants Program for the Spanish Capital Goods Construction Industry," in which, besides providing information on the aforementioned points, there was included a program on quality guarantee, with its pertinent questionnaires,which enabled each firm to assess its status in this area, to begin thinking about the quality guarantee requirements in those firms that had not yet been introduced into the nuclear area and to intensify that thinking among the others which had in some way participated in the powerplants that are in operation.

The main action taken by the Spanish Government to increase national participation consisted of the following:

a. "Joint manufactures" system. The legislation appeared in 1967, promulgated by the Ministry of Commerce; through its implementation, each national manufacturer was granted a very sizable tariff discount on those materials or parts that must be imported, and are to be incorporated or used in the construction of the equipment manufactured in the country, provided the percentage of wholly national application exceeds the minimal amounts stipulated in the pertinent regulation.

b. Industries of preferential interest. The legislation was established by the Ministry of Industry and, through its implementation, the firms granted this status, after having competed in public bidding, receive benefits of a customs, tax and credit nature. Through the administration, a series of requirements is established, such as those relating to type of product to be manufactured, production volume, investment, location, etc.

c. System of "concerted action" between the Spanish administration and a particular client. In the concrete instance of the nuclear powerplants, the client is the company which owns the powerplant. Through the implementation of this system, the firm receives a series of benefits, which may later be extended to include the different suppliers of equipment and services for the powerplant or the facility involved.

As a result of these actions, combined with engagement in other activities, it may be said that the Spanish participation in the construction of nuclear powerplants that will go into service starting in 1985 will exceed 80 percent; and, specifically in the portion associated with capital goods, it will exceed 70 percent.

5. The Nuclear Fuel Cycle

The startup of this program has required the creation of an infrastructure that will guarantee the management of the fuel in each stage of the cycle. The two entities responsible for this activity are the Nuclear Energy Board (JEN) and Empresa Nacional del Uranio [National Uranium Enterprise] (ENUSA). The distribution of ENUSA's capital is 60 percent INI and 40 percent JEN.

Since its creation, JEN has been concerned with uranium prospecting and the development of the technology for the various phases of the nuclear fuel cycle. ENUSA was created in 1972, and the purpose associated with it was industrial activity and the unified management of the fuel cycle. It was later entrusted with uranium prospecting outside of the country, the internal prospecting remaining in the hands of JEN.

In 1981, at the government's behest, all of JEN's activities relating to uranium prospecting and the production of concentrates were transferred to ENUSA, and regulations were established for the cooperation between the two institutions, with ENUSA assigned uranium prospecting both inside and outside of Spain, and all the industrial activities entailed in managing the fuel cycle. JEN would be responsible for the technological research and development programs that must serve as a backup for ENUSA's industrial activities.

The current situation in Spain with regard to the different phases of the fuel cycle is as follows:

Spanish uranium resources amount to about 25,000 tons of uranium, which can be utilized at a cost of under $30 per pound of U_3O_8.

In 1974, the government set up a National Uranium Exploration Plan, of 10 years' duration, which JEN managed until 1981. This plan made it possible to increase the prospecting activity to a large extent.

For the production of concentrates, ENUSA has a facility in Ciudad Rodrigo (Salamanca), with a production of 130 tons of uranium oxide, and an experimental plant in Don Benito (Badajoz), producing 30 tons. The facility which JEN had since 1959 in Andujar (Jaen), which has been producing 70 tons per year uninterruptedly, is in the process of dismantling. Spain also has the technology for recovering uranium from phosphoric acid, the process for which, developed by JEN, has been transferred to ENUSA for commercialization by the latter.

The current program calls for an increase in the production of uranium concentrates until it reaches a capacity of 800 tons of U_3O_8 per year in 1985.

To date, Spain has not engaged in any activity related to uranium enrichment facilities; and hence its requirements, the handling of which has also been assigned to ENUSA, are being met by means of contracts abroad or participation in multinational firms. There are three sources of supply: the United States, through the contracts signed for specific powerplants, which have met all our needs thus far; the Soviet Union, through contracts with TECHNABEXPORT; and, finally, through ENUSA's 11.1 percent participation in EURODIF [European Diffusion Agency].

At the present time, the fuel elements used by the Spanish nuclear powerplants are imported, but the Spanish market volume warrants the construction of a national factory. For this reason, ENUSA has a plant under construction which will make it possible to produce fuel elements for light water reactors in their two versions: PWR and BWR, starting in 1983.

The annual production of irradiated fuel in the Spanish light water nuclear powerplants will increase from about 20 tons of uranium content in 1977 to about 290 tons in 1987, with a total of about 1,500 tons of uranium content during the period 1977-87. Up until now, the irradiated fuel has been sent to France, in the case of the Vandellos powerplant, and to the United Kingdom, in the case of the Jose Cabrera and Garona powerplants, for reprocessing; nevertheless, the problems that exist currently necessitate a new approach.

Spain is of the opinion that the reprocessing of the irradiated fuel elements should be carried out for the recovery of the plutonium and unburned uranium; because we cannot, nor can many other countries, dispense with the energy contained in these fuels. It is known that there are problems at present concerning nuclear proliferation, but these problems must be solved, and the peaceful use of plutonium must be guaranteed, without interference in the utilization of this energy source.

From this standpoint, the following solutions are considered the most feasible for the Spanish nuclear program:

a. An increase in the capacity of the pools in the nuclear powerplants for storing irradiated fuel.

b. Construction by ENUSA of irradiated fuel storage facilities, whether centralized or not; which, combined with the foregoing decision, would make it possible to insure the normal operation of the Spanish nuclear powerplants.

A joint program is being carried out between JEN, ENUSA and Equipos Nucleares, S.A. [Nuclear Equipment, Inc] (ENSA) for the development, in Spain, of containers for the dry storage and transportation of irradiated fuels.

c. Implementation by JEN of a technological research and development program, including the construction of a pilot plant, so as to have the necessary technology available for the construction of an industrial plant for reprocessing irradiated fuels. When the technical problems have been solved, and the requirements of the Spanish nuclear program so warrant (possibly by 1995), construction by ENUSA of the industrial plant.

d. Implementation, by JEN, of a research and development program for the treatment of highly active radioactive waste.

e. Conducting, by JEN, of long-term studies to determine the most favorable conditions (geological formations or other solutions) for storing this waste.

6. The Capital Goods Industry

The current status of the industry producing capital goods for nuclear powerplants has been possible thanks to a series of measures on the part of the Spanish Government, in cooperation with national industry, leading to a reinforcement of the existing industries, and ordering the manufacture of large components, such as pressure vessels and steam generators.

On 24 March 1972, the then Ministry of Industry promulgated a decree whereby the sector manufacturing auxiliary steam generator systems and their components was declared of preferential interest, and bidding was called for the construction and operation of an industrial plant for the manufacture of these systems. Through this bidding, the firm Equipos Nucleares, S.A., was set up, assuming the commitment to manufacture at least the following components: vessel of the reactor, with its internal parts, steam generators, pressurizers and primary circuit pipes. At the same time, the levels of nationalization were established, both at the beginning of the industrial activity and for 4 years; and it was required that a technical office with suitable features enabling it to use the available technology be organized, a technical office which, 4 years after the activity began, should be capable of implementing the complete project involving the aforementioned components. Other areas covered the implementation of technological research and development projects, to be carried out in the field of the assigned components.

The activity of Equipos Nucleares, S.A., in compliance with the stipulations of the decree in question, has made it possible to start up a factory, located in Santander Bay, with a capacity to produce the necessary components for all the Spanish nuclear powerplants that go into operation beginning in 1982.

7. Personnel Training

The Nuclear Energy Board has an Institute of Nuclear Studies, which is charged with training personnel in the nuclear field.

This institute has organized nuclear engineering courses for postgraduates, operators and supervisors of nuclear and radioactive facilities, radiological safety chiefs, etc., attended by both Spanish and foreign students, the latter being mainly Latin Americans. Through cooperation between the Spanish Staate and the International Atomic Energy Agency, the institute has also organized courses of an international nature on nuclear subjects.

Aware of this need for personnel training, the Spanish electric companies created the TECNATOM enterprise, specializing in the training and qualification of personnel engaged in operating nuclear powerplants, for which purpose it has simulators of light water powerplants in their two versions, PWR and BWR.

The companies, in turn, have organized courses and seminars for training their own personnel, and the scientific and polytechnical universities include case study courses for postgraduates on nuclear subjects.

At present, the training of the operational personnel of the Spanish nuclear powerplants is being conducted entirely in Spain.

Special mention should be made of the training of personnel in the area of nuclear safety. There is no doubt that the accident at the TMI-2 nuclear powerplant is considered one of the best schools of instruction for the future, in many areas, and particularly the human one. The greatest progress in a technology is achieved by making a painstaking analysis of the mistakes that have occurred and by improving the systems so as to avoid them in the future. Included among these errors are the human ones.

The accident at TMI-2 made it possible to acquire an awareness of the problem, and to focus attention on two areas of enormous importance to nuclear safety: the training of personnel who operate the powerplants and the interaction between man and machine. Almost immediately after the accident, a review was undertaken of the training of the powerplant personnel, their mental state and their training.

But it is unquestionable that this review of the training should also include the individuals who are in any way associated with the agencies responsible for monitoring and seeing to it that there is maximum compliance with the regulations that exist in the area of nuclear safety. Nuclear safety is not a static, multi-disciplinary system, but rather a dynamic one; and hence the nuclear standards and regulations must be alive, and must constantly assimilate the information which has been gained from experience and research.

An overly administrative and regulatory concept of safety could lead us into separation from, or disregard for the real technical problems involved in the operation of the powerplant; and therefore the safety technician must be constantly trained, experiencing the same problems confronted by the technicians who operate it, analyzing the incidents (major or minor) which occur during the operation and studying the proper corrective measures.

Obviously, this is not an easy problem, and the ideal level has not yet been attained in Spain. Nevertheless, it is expected that the new Spanish situation created by the recent measures in this regard, prominent among which is the creation of the Nuclear Safety Council, on 22 April 1980, will quickly remedy the present shortcomings.

8. Design and Construction of Nuclear Powerplants

Like many other countries, Spain has not developed a technology of its own for nuclear powerplants, nor has it acquired a foreign permit; nevertheless, it has been increasing its participation in the design and construction of the Spanish nuclear powerplants, as has been mentioned previously. For example, whereas the national participation in the "first generation" powerplants (the first three powerplants) was approximately 40 percent, in those of the "second generation" (those in an advanced stage of construction) it has reached as much as 70 percent, and will exceed 80 percent in those whose construction has begun recently ("third generation" powerplants).

The various sectors are participating in this construction as follows:

a. Engineering

The Spanish engineering firms which had experience in the design and construction of conventional powerplants have extended their activities to the nuclear field; 80 percent of the engineering work on the "second generation" powerplants has been done by Spanish companies, and it is estimated that the figure will be 90 percent in the case of the powerplants the construction of which has started more recently.

b. Construction work and installation

This is done completely with national facilities.

c. Capital goods

As we have said, there is in Spain the firm Equipos Nucleares, S.A. (ENSA), which was established in 1973, and which specializes in the manufacture of all the elements comprising the nuclear boiler (reactor vessel, steam generators, etc.), with the exception of the primary circulation pumps.

Also manufactured in Spain is a sizable portion of the pipes, valves, bearings, etc., of the nuclear boiler, with dependence on foreign countries for some of the materials used in them.

Approximately 35 percent of the equipment for the nuclear boiler is currently manufactured in Spain; a figure that will rise to 70 percent in the powerplants the construction of which started recently.

Turbines with a capacity of up to 1,000 MW are manufactured in Spain, with a percentage of national participation amounting to 38 percent. It is estimated that this percentage will be 50 within the next few years. Of the rest of the powerplant equipment, 70 percent of that for the powerplants which will soon go into service has been manufactured in Spain, and for the future ones, the figure will reach 90 percent.

9. Research and Development in Nuclear Energy

Since 1951, the Nuclear Energy Board (JEN), an autonomous agency which now comes under the Ministry of Industry and Energy, has assumed the role of a center for technological research and development in the nuclear field. Although, since its creation, JEN has had authority in all fields associated with nuclear energy, including that of a regulatory agency, as a result of recent rulings (creation of the Nuclear Safety Council and transfer to ENUSA of the functions which JEN had been assigned in connection with the nuclear fuel cycle), it has remained clearly defined as the official research and development agency in the nuclear area, required to lend technological backing to both the Nuclear Safety Council and ENUSA. It is, in addition, the government's advisory organ in the realm of nuclear policy, providing technical assistance to industry and maintaining relations with the counterpart agencies in other countries.

To carry out its research and development work, JEN has a research center in Madrid (the Juan Vigon National Nuclear Energy Center), and another in the province of Soria (200 kilometers from Madrid), which is in the construction phase, having been authorized by the government in October 1980. This second center will engage in the pilot scale development of a technology for treating irradiated fuels and liquid and solid radioactive waste.

JEN's current potential is for 2,025 persons, 300 of whom are higher-level degree-holders engaged in research. The budget for 1982 is 4.710 billion pesetas.

In order to carry out the missions assigned to JEN, based on the current legislation and the directives in the National Energy Plan, all the activities have been arranged in the following work programs:

JEN Research and Development Programs

1. Nuclear materials
2. Design, manufacture and evaluation of fuel elements
3. Storage and reprocessing of irradiated fuel elements
4. Treatment of radioactive waste
5. Storage of radioactive waste
6. Nuclear reactors
7. Thermonuclear fusion
8. Isotopes
9. Metrology of ionizing radiation
10. Nuclear instrumentation
11. Nuclear safety
12. Radiological protection
13. Nuclear biomedicine and medicine
14. Environment
15. Basic research
16. Personnel training

1. Nuclear materials: the purpose of which is the development of processes for using uranium from ores and as a by-product of potential sources (fertilizers and lignites). This development is carried out on both the national and international levels, achieving, with the cooperation of engineering firms, the development of detail engineering for industrial facilities. The program includes technological backing for ENUSA, both in the mineralogical areas and in the ore beneficiation processes and the procurement of the intermediate compounds in the facilities owned by this enterprise.

2. Design, manufacture and evaluation of fuel elements: aimed at the study of methods for the design and manufacture of fuel elements for research reactors with different uranium contents and varying geometrical features; the irradiation of fuel elements in experiemental and power reactors for the purpose of checking the viability of the design and the proper behavior of the fuel; and the evaluation of the performance of irradiated fuel elements, in order to make the pertinent changes in the design and manufacture of fuel element prototypes for power reactors, and thus contribute national technology to the fuel cycle, improving its efficiency.

3. Storage and reprocessing of irradiated fuel elements: the purpose of which is the development of the basic technology and the nuclear safety aspects both for the storage of irradiated fuels in light water reactors, including the underwater (pool) method and the dry (container) method, and for the treatment of these fuels, in order to have a national technology available that will make it possible, when necessary, to achieve the industrial phase. The program includes the design and construction of a pilot plant for treating irradiated fuels in light water reactors, and a treatment plant for irradiated fuels in research reactors, both destined for the new Nuclear Research Center in Soria.

4. Treatment of radioactive waste: the purpose of which is the operation of the pilot treatment plants of the Juan Vigon National Nuclear Energy Center, in order to gain experience and provide service for the facilities of the center itself and for other facilities treating the radioactive waste resulting from the Spanish nuclear program. The program includes the design and construction of the radioactive waste treatment facilities of the Soria Nuclear Research Center.

5. Storage of radioactive waste: aimed at fulfilling the terms of Royal Decree 2967/1979, of 7 December, whereby JEN was assigned the final storage of radioactive waste, consisting of the operation of the storage facilities owned by JEN in Sierra Albarrana (Cordoba), and the investigation, selection and study of deep geological formations (granite and salt), as well as the development of the necessary technology for the construction of definitive storage facilities.

6. Nuclear reactors: including the study of the scientific and technical aspects relating to the calculation and design of the core of the reactors and its performance, research on the operation of reactors from the standpoint of instrumentation and control, and studies related to the manufacture, properties and performance of materials for equipment and components. The program includes the operation and maintenance of the research reactors owned by JEN, the design of a new research reactor (JEN-3) destined for the Soria Nuclear Research Center and cooperation with Latin American countries on the construction of research reactors.

7. Thermonuclear fusion: the medium-term purpose of which consists of attaining active inclusion on the international level in the field of plasma physics, particularly of that created in Tokamak type toroidal mechanisms, as well as simultaneous familiarization with the pertinent technical problems. Over the longer term, and depending on the impetus that can be given to the program, the latter will include the study of materials and other specific problems relating to the future fusion reactors. The program has a small TJ-1 Tokamak, the adjustment of which is being completed.

8. Isotopes: aimed at research, production and applications of stable and radioactive isotopes, as well as of the compounds which they contain, in order to raise the level of national coverage of the demand for products and services existing in the sector.. Special attention is given to the radioisotopes with applications in nuclear medicine, both the positron emitters, by means of the plan for a cyclotron, and the emitters in the Madrid and Soria Research Centers. Included in this program is the design of a multiple-use irradiation unit destined for the Soria Center.

9. Metrology of ionizing radiation: the purpose of which is the development of methods for measuring and determining the physical constants which intervene therein, the performance of calibration work and technological backing for the nuclear and radioactive facilities, through their dosimetry and protection departments. The program includes the establishment of a national metrological system.

10. Nuclear instrumentation: aimed at increasing its own coverage of technology and services in the following preferential areas: development of nucleonic systems and equipment, of radiological and radio-protection instrumentation, automatization and control of processes with microprocessing applications, and design and development of equipment and systems for control and safety of nuclear reactors. The program includes the transfer of technology to industry, through agreements for cooperation and the concession of licenses for industrialization and commercialization.

11. Nuclear safety: the purpose of which is to advise those in charge of the JEN nuclear and radioactive facilities in the application of the principles, criteria, regulations, standards and guides for safety with regard to the location, design, construction, checking, operation and closing of the facilities, as well as in the preparation of the safety documents required by law. The program includes the performance of research activities in the area of nuclear safety, on its own initiative, or at the request of CSN [Nuclear Safety Council], the industry or other national or international institutions.

12. Radiological protection: the purpose of which is to advise those in charge of the JEN nuclear and radioactive facilities in the application of the principles, criteria, regulations, standards and guides for protection against ionizing radiation, as well as to check compliance with the requirements, restrictions and conditions in effect regarding radiological protection. The program includes the dosimetry of JEN's own personnel, both that attributed to internal radiation and that attributed to external radiation, as well as that demanded by outside entities.

13. Nuclear biomedicine and medicine: the purpose of which is to study the biological effects of radiation, and to cooperate with the competent authorities in the establishment of programs for treating cases of possible irradiation or contamination resulting from the development of applications of nuclear energy. In the field of nuclear medicine, the program includes research on new processes, providing technological backing to the radioactive facilities that exist in the country.

14. Environment: aimed at determining the radioactive content of samples of radioactive waste and fallout from the JEN nuclear and radioactive facilities, and of the mineral resources, fauna and flora in the zones of influence of these facilities, in order to ascertain the radiological impact. The program includes the performance of services involving radioanalysis of industrial and environmental samples, at the request of CSN, industry and other public or private institutions.

15. Basic research: the purpose of which is to conduct theoretical and experimental studies aimed essentially at disseminating the current information on the structure of matter. Within this broad area, special attention is given to subnuclear physics (primarily in cooperation with ECNR [European Council for Nuclear Research], to the effect of radiation on solids, to molecular biophysics and to the spectrometry of ionizing radiation.

16. Personnel training: the purpose of which is to train the personnel involved in the nuclear programs, both those of JEN and the outside ones, encouraging and fostering the participation of universities, occupational training schools and professional associations, as well as public or private firms associated with the construction and operation of nuclear powerplants, or with the use of radioactive istotopes and ionizing radiation. The program includes the specialized training of graduates and grant-holders, and the provision of aid for outside research.

10. Nuclear Power in the Spanish Energy Plans

The favorable experience of the first three nuclear powerplants, combined with the energy needs foreseen during the 1980's, prompted, in 1972, the decision to construct a new series of nuclear powerplants, consisting of seven units located on four different sites. Six of these units were of the pressurized water type, each for 930 MWe, with two located in Almaraz (Caceres), two in Lemoniz (Vizcaya) and two in Asco (Tarragona). The boiling water unit is for 975 MWe, and is located in Cofrentes (Valencia). All of these units, which total 6,555 MWe, are currently under construction, except for the No 1 unit in Almaraz, which went into operation last year.

When the energy crisis occurred in 1973, Spain, like other countries, had to reconsider its energy policy.

At the end of 1974, the first National Energy Plan, of 10 years' duration, was drawn up, and it was assumed that, as a minimum, the gross domestic product (GDP) would increase by 5 percent per year during that period. The elasticity between the growth in the GDP and that in energy consumption was set at 1.2, which led to the assumption of an average cumulative increase in the demand for energy of 6 percent per year. Nevertheless, as a result of the economic crisis, the results accrued in Spanish development have fallen short of those anticipated in 1974.

In view of this situation, it became necessary to draw up a new National Energy Plan, which was submitted to the Congress of Deputies in May 1978. In this plan, which is in effect for the period 1979-87, the figure of 4 percent was estimated for the increment in GDP and that of 1.05 for the elasticity between the GDP growth and the energy consumption. The reduction in the latter parameter in comparison with that estimated previously was due to the attempt to adopt effective measures, both in energy savings and in the promotion of industries with a lesser energy consumption per GDP unit.

The plan estimated an average increase in electric power production of 6.5 percent for the period 1979-87, with 59.700 billion kilowatt hours to be produced by nuclear powerplants in the latter year: in other words, 34 percent of the total electric power. To achieve this, it was necessary to have an installed nuclear power of 11,550 MWe; and therefore, before 1987 it would be necessary to build and put into operation four new powerplants, each for 1,000 MWe, to complete those in operation or under construction at that time.

At present, the Spanish supply of nuclear powerplants is that shown in Table II. In the powerplants under construction, the year of entry into service has been estimated on the basis of the current status.

In July 1979, the Plenum of the Congress of Deputies passed a series of resolutions relating to the Plan, the content of which has since then guided the energy policy pursued by the government. In 1981, complying with these resolutions, it again submitted the Plan updated for the decade 1981-90 to the Congress.

The forecasts of the energy balance included in this updated Plan are those shown in Table III.

Table II.

Spanish Nuclear Powerplants in Operation

Powerplant	Power (MWe)	Year of Entry Into Service
J. Cabrera	160	1968
Garona	460	1970
Vandellos-1	500	1972
Almaraz-1	930	1981

Spanish Nuclear Powerplans Under Construction

Powerplant	Power (MWe)	Year of Entry Into Service
Asco-1	930	1982
Almaraz-2	930	1983
Lemoniz-1	930	1983
Cofrentes	975	1983
Asco-2	930	1984
Lemoniz-2	930	1985
Valdecaballeros-1	975	1986
Vandellos-2	982	1986
Trillo-1	1,032	1986
Valdecaballeros-2	975	1988
Trillo-2	1,032	1990

Spanish Nuclear Powerplants With Prior Authorization

Powerplant	Power (MWe)	Year of Entry Into Service
Vandellos-3	~1,000	?
Sayago	~1,000	?
Regodola	~1,000	?

Table III.

Forecasts of the Energy Balance

	1981		1985		1990	
Source	Mtec	%	Mtec	%	Mtec	%
Coal	22.4	21.3	30.1	24.3	34.7	22.8
Oil	64.5	61.4	61.3	49.3	68.8	45.2
Natural gas	2.8	2.6	6.7	5.4	9.3	6.1
Nuclear power	3.5	3.4	13.1	10.6	22.9	15.1
Water power	11.9	11.3	12.5	10.0	13.9	9.2
Others	-	-	0.5	0.4	2.5	1.6
Totals:	105.1	100,0	124.2	100.0	152.1	100.0

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